POWER

Vol. 34 NEW YORK, DECEMBER 5, 1911 No. 23

IN a factory, demands for power outgrew the capacity of the engine and boiler, and the capacity was to be doubled immediately, with provisions for future increase in capacity without changes in the building.

The engineer who had operated the plant was consulted as to the advantages of several different types of installation: the reciprocating engine, simple or compound, with or without condenser; oil and gas engines, belted or with electric transmission, and the turbine with group or individual motor drive. But as the business had outgrown the capacity of the motive power, so had the requirements of the motive power outgrown the capacity of the engineer, and he was worthless as an adviser.

He had been in the place most of his working years. It was here that he learned to handle the engine, boilers and pumps. He learned to do this well, but he never learned more. The boilers were clean and well cared for; the pumps were kept mechanically in good working order; the engine was attended to with all of the faithfulness of a plodder who could almost use an indicator. As an engine tender he had been a success, but he had never lifted his eyes to the possibilities of his calling.

The old engine ran noncondensing, so he never thought of how much a knowledge of the principles of condenser operations might benefit him.

Shafting and belting transmitted the power to the various machines and he never considered the advantages of the electric drive.

Of the turbine he had heard conflicting stories, but had never seen one. He was a "practical" engineer who had no time for frills, theories and technical papers. He had run his engine and boiler for years without a shutdown for any accident to the machinery under his care. He had been a faithful, conscientious, patient worker, with not a thought beyond the daily routine of his duties.

But the plant, already past his control, was to be enlarged and along lines in which he was ignorant. Finding him lacking in those things needed for the handling of the new and radically different plant, the consulting engineer under whose supervision the new apparatus was being installed, asked the manager one day what arrangements were being made to get a man to take charge of the new machinery.

He was told that as yet nothing had been done, as it was expected that the old engineer would be able to handle it.

"I know," said the engineer, "that you appreciate the service of the old man, for he has been faithful to the extent of his ability. He has served the engine, but he has not served you in that he has not kept up with the times. He grew to the job when the responsibilities were light. But while the plant grew he stood still. He has kept the engine from going to wreck. He has confidence in the old engine, but none in himself. He can run an engine, but he cannot run a power plant.

"Charge must be given to a man who has lived up to his opportunities for keeping in touch with progress in the generation and transmission of power. This your man has not done, and one who has must be selected. I am not misjudging the old man's mistaken fidelity, and a position among the assistants might be found where patient, faithful plodding will suffice. But for your motive power you must have a man who knows and one who knows that he knows."

The manager thought a moment, and then said: "I think you are right. We will have to look for the right man."

The engineer was right, and this manager is only one of many who are looking for the right men—not men to run engines and boilers but men to run steam power plants.

Where Current Is Sold for 2½ Cents

A central station notable for economy in space occupied by the apparatus. Plant contains Parsons turbines, centrifugal circulating pumps, motor generators, elevator pumps, etc.

The cooling tower, built according to design recently suggested by J. R. Bibbins, has proved to be efficient.

An ingenious oil storage-tank indicator is described.

The city of San Francisco is blessed, or otherwise, whichever way one looks at the matter, by having several separate public light and power companies, supposedly in active competition. The plant of one of these companies, the Municipal Light and Power Company, is interesting from a mechanical point of view in several particulars. Perhaps it is all the more interesting by reason of the fact that the company sells current at a flat rate of 2½ cents per kilowatt-hour.

The plant is located on Stevenson street, almost directly in back of the Claus Spreckels building, which is on the corner of Market and Third streets, in the heart of the business district of the city. From the consumer's point of view there is but one unfortunate feature about this plant—it is too small. Its total rated capacity is only 2240 kilowatts and its service lines extend for only a few blocks.

From a mechanical standpoint the plant is interesting because of the large amount of apparatus contained within the given area. Fig. 1, showing a general view of the generator section of the plant, serves to illustrate the congested conditions. Fig. 2 is a plan view showing the location of the main pieces of apparatus.

The plant contains three Westinghouse-Parsons turbo-generators; two are of 650 kilowatts and one is of 940 kilowatts rated capacity. All three units run at 3600 revolutions per minute and generate current at 2300 volts. The current is transmitted at this voltage and stepped down at destination to 240 and 120 volts.

The two small machines have one Worthington surface condenser each, containing 2818 square feet of condensing surface. The wet-vacuum pumps, one for each unit, are of the Blake "Featherweight" simplex type, 7½ by 14 by 10 inches in size; there are no dry-vacuum pumps.

The condenser for the large machine is a Wheeler, containing 4107 square feet of condensing surface and equipped with a 10 by 20 by 16-inch Blake, "Featherweight" simplex wet-vacuum pump and a 10 by 20-inch "Rotrex" dry-vacuum pump, chain driven by a 6½-horsepower motor.

Cooling Tower

As the Municipal Company's plant is located too far from the waterfront for sea water to be available for condensing purposes, fresh water is used, recooled in a cooling tower. A forced-draft type of tower was erected for these reasons: the forced-draft type loses no water through windage, which is a point in its favor where water is costly; the forced-draft tower is less bulky than the natural-draft or atmospheric types, hence it is cheaper to build and requires less foundation area. A point which is sometimes against it is the fact that it requires power to run the blast fan. In the present instance this point counts for practically nothing, because the fan is steam-engine driven and the exhaust from the engine is sold for heating purposes.

The tower originally installed did not prove to be adequate and a new tower, of different design, has recently been built. With the old tower it was difficult to get a vacuum better than 23 or 24 inches; with the new one 28½ inches are frequently obtained. The old tower was filled with sets of horizontal wooden gratings and the air blast was supplied by the large disk fan shown in Fig. 3. The chimney for this tower is the large circular steel stack shown at the left in Fig. 4. Two faults were discovered after the tower was put into operation. The arrangement of the gratings did not divide the water into fine enough particles to produce good cooling effect. And the fan was not of the proper type to operate successfully against the friction head of the tower and furnish the required volume of air.

The second tower is the rectangular corrugated sheet-iron structure seen in Fig. 4. This tower is filled with tiers of very nearly vertical wood-lath mats in the manner and of the design suggested by J. R. Bibbins in a paper presented to the American Society of Mechanical Engineers about two years ago, an abstract of which was printed in POWER for January 18, 1910.

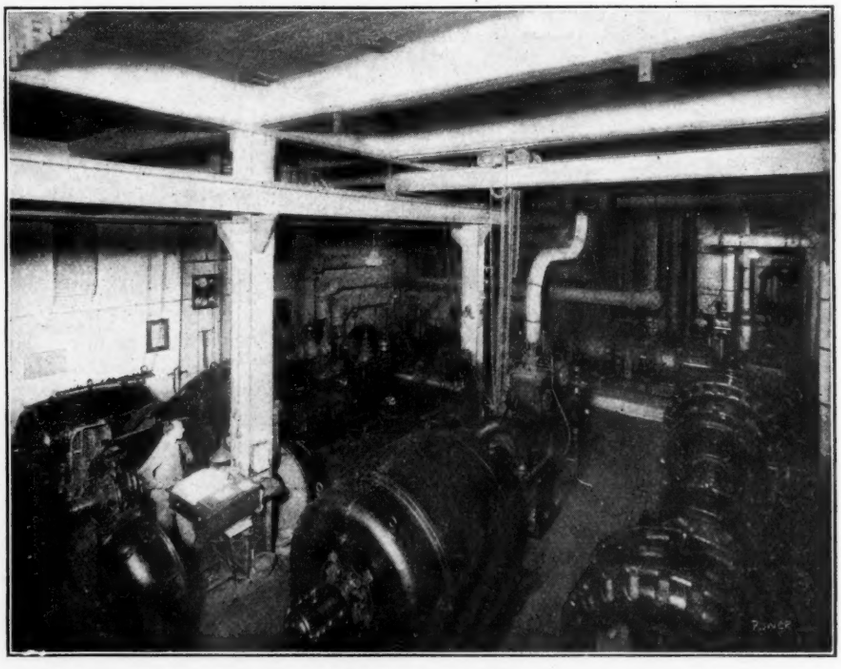

FIG. 1. PART OF THE EQUIPMENT OF THE MUNICIPAL PLANT

The fan which furnishes the air blast for the new tower is of the Sirocco type and was furnished by the American Blower Company. It has an 8 by 8-foot runner, double inlet, and a 64 by 128-inch outlet. Under normal operation the fan makes 55 revolutions per minute and delivers about 92,000 cubic feet of air per minute against a head of ¼ inch, water gage.

Circulating-water Pumps

There are three circulating water pumps of the centrifugal type, 10 inches in size. Two of these are direct driven by 50-horsepower induction motors and the third is driven by a 75-horsepower motor, all run at a speed of 850 revolutions per minute. The piping is so arranged and bypassed that any combination of pumps may be used.

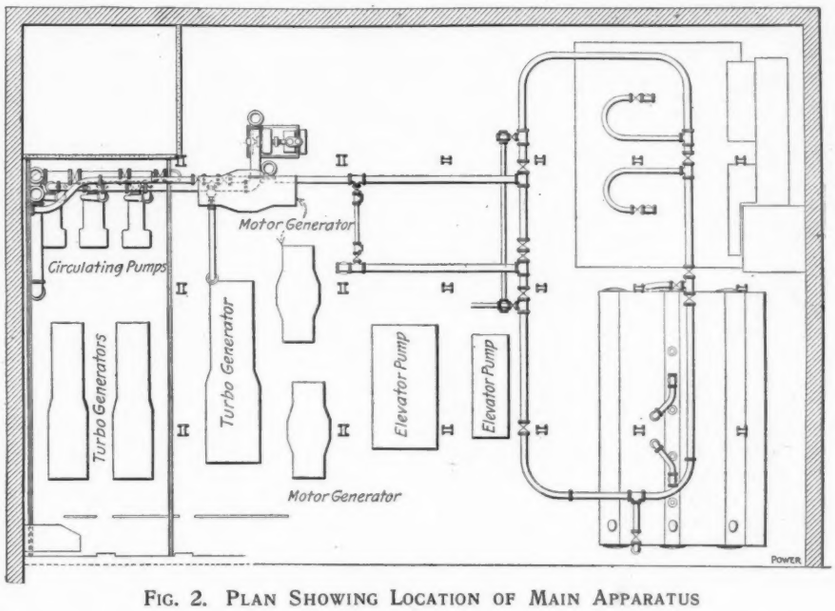

Fig. 2. Plan Showing Location of Main Apparatus

Boilers

The boiler equipment consists of four specially constructed Stirling boilers, specially constructed to accommodate the small amount of head room available. One is of 350 horsepower rated capacity and the other three are of 450. Two of the larger boilers have superheaters which effect a superheat of 50 degrees. Steam is generated at 170 pounds pressure, gage.

As in almost every steam plant in California, the fuel is crude oil. This is stored in three tanks of 110 gallons capacity each, buried 2 feet below the grate level as prescribed by city ordinance.

The oil is pumped to the burners by a 6x4x6-inch duplex pump, through a tubular heater in which it is heated to a temperature of about 150 degrees. The oil-pumping equipment is in duplicate.

The oil pressure is regulated by a Witt pump governor which is set for a pressure of 50 pounds per square inch. The steam used by the burners is superheated by being passed through a loop of steam pipe which is hung on the inside face of the front wall of the boiler furnace. The supply of steam to the burners is regulated by hand. Hammel back-shot burners are used in Hammel furnaces. The small boiler has three burners and the large boilers have four each.

Oil-storage Tank Indicator

An ingenious arrangement for ascertaining the quantity of oil in the storage tanks has been devised by the chief engineer. It is illustrated diagrammatically in Fig. 5. A homemade glass U-tube of suitable size is mounted on the board *A*. A ⅛-inch wrought-iron pipe is connected to one leg of the tube and run to the bottom of the storage tank as shown. Anywhere between the U-tube and the tank a pipe connection is made with the compressed-air system.

By opening the valve of the compressed-air pipe a very slight amount, the air pressure in pipe *B* gradually builds up until all of the oil is forced out at the lower end and air beings to escape up through the oil. Of course, there must be nothing but atmospheric pressure in the oil tank. The air pressure in *B* also displaces the mercury in the U-tube, the amount depending on the depth of the oil in the storage tank, the displaced mercury being balanced, so to speak, by the displaced oil. Thus the scale on the board behind the U-tube may be graduated in barrels of oil and the amount on hand may be ascertained at a glance. The accuracy of this arangement depends on the pipe *B* and its connections being air tight.

This same principle may be applied equally well to water-storage tanks, etc.

The three motor-generator sets shown in Figs. 1 and 2 are used for electric-elevator service exclusively. They generate direct current at 250 volts. Two are of 150 kilowatts capacity and one is of 300.

Elevator Pumps

The plant contains two hydraulic-elevator pumps. The larger one is a rebuilt compound duplex pump, the water end of which once belonged to a Crane crank-and-flywheel type. The steam end of the original machine was removed and a new steam end, furnished by the George Dow Pump Company, was put on. The sizes of the original steam cylinders were 16 and 20 inches in diameter and 16 inches long. The new steam cylinders are 12 and 20 inches in diameter with an 18-inch stroke; the water cylinders are 8 inches in diameter. The clearance which existed with the old machine made it possible to increase the stroke from 16 to 18 inches with very little alteration to the water cylinders.

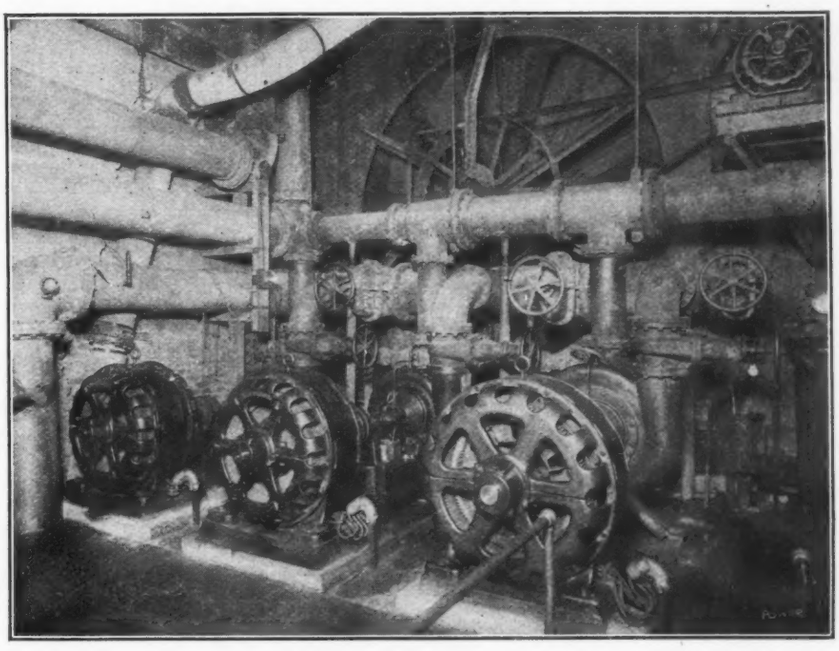

Fig. 3. The Circulating Pumps

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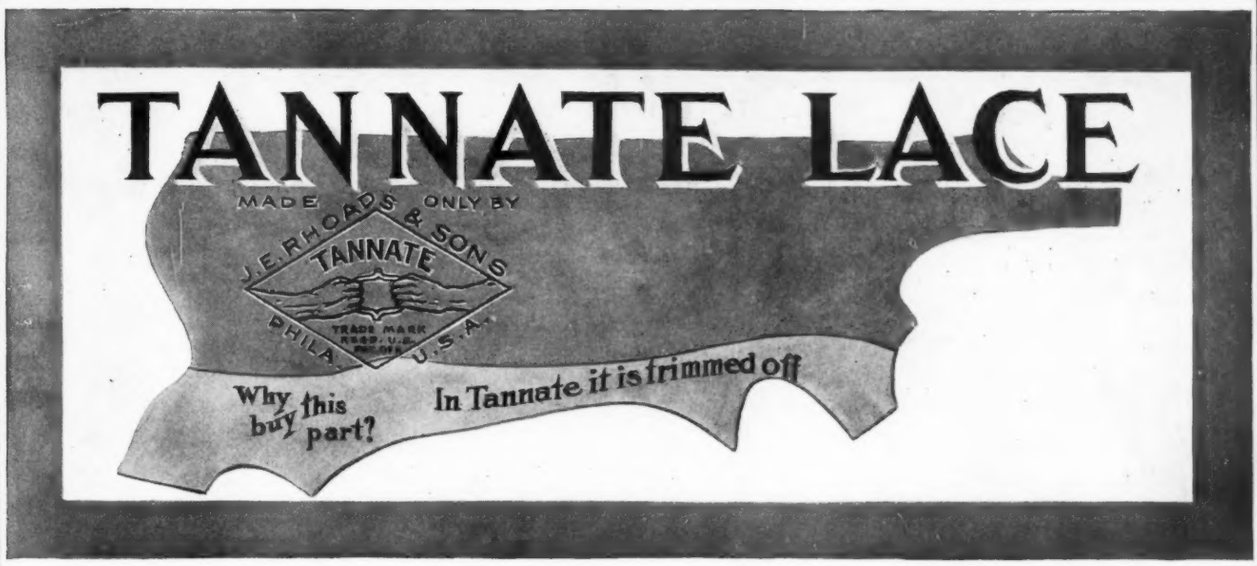

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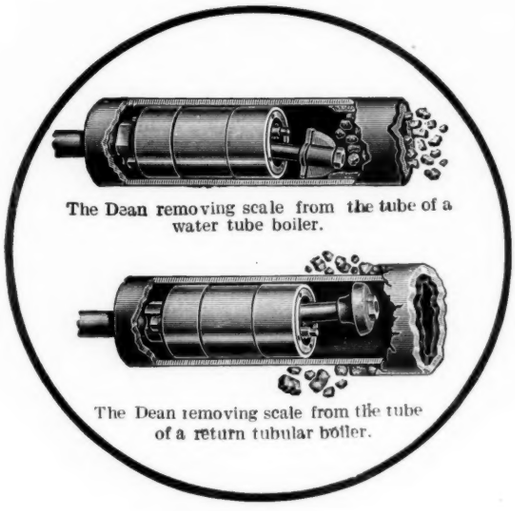

The Dean removing scale from the tube of a water tube boiler.

The Dean removing scale from the tube of a return tubular boiler.

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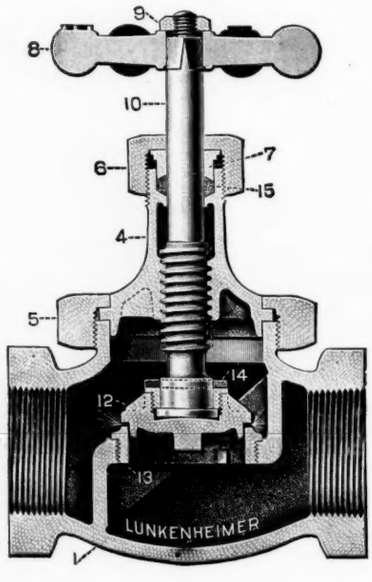

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POWER

Vol. 34 NEW YORK, DECEMBER 5, 1911 No. 23

IN a factory, demands for power outgrew the capacity of the engine and boiler, and the capacity was to be doubled immediately, with provisions for future increase in capacity without changes in the building.

The engineer who had operated the plant was consulted as to the advantages of several different types of installation: the reciprocating engine, simple or compound, with or without condenser; oil and gas engines, belted or with electric transmission, and the turbine with group or individual motor drive. But as the business had outgrown the capacity of the motive power, so had the requirements of the motive power outgrown the capacity of the engineer, and he was worthless as an adviser.

He had been in the place most of his working years. It was here that he learned to handle the engine, boilers and pumps. He learned to do this well, but he never learned more. The boilers were clean and well cared for; the pumps were kept mechanically in good working order; the engine was attended to with all of the faithfulness of a plodder who could almost use an indicator. As an engine tender he had been a success, but he had never lifted his eyes to the possibilities of his calling.

The old engine ran noncondensing, so he never thought of how much a knowledge of the principles of condenser operations might benefit him.

Shafting and belting transmitted the power to the various machines and he never considered the advantages of the electric drive.

Of the turbine he had heard conflicting stories, but had never seen one. He was a "practical" engineer who had no time for frills, theories and technical papers. He had run his engine and boiler for years without a shutdown for any accident to the machinery under his care. He had been a faithful, conscientious, patient worker, with not a thought beyond the daily routine of his duties.

But the plant, already past his control, was to be enlarged and along lines in which he was ignorant. Finding him lacking in those things needed for the handling of the new and radically different plant, the consulting engineer under whose supervision the new apparatus was being installed, asked the manager one day what arrangements were being made to get a man to take charge of the new machinery.

He was told that as yet nothing had been done, as it was expected that the old engineer would be able to handle it.

"I know," said the engineer, "that you appreciate the service of the old man, for he has been faithful to the extent of his ability. He has served the engine, but he has not served you in that he has not kept up with the times. He grew to the job when the responsibilities were light. But while the plant grew he stood still. He has kept the engine from going to wreck. He has confidence in the old engine, but none in himself. He can run an engine, but he cannot run a power plant.

"Charge must be given to a man who has lived up to his opportunities for keeping in touch with progress in the generation and transmission of power. This your man has not done, and one who has must be selected. I am not misjudging the old man's mistaken fidelity, and a position among the assistants might be found where patient, faithful plodding will suffice. But for your motive power you must have a man who knows and one who knows that he knows."

The manager thought a moment, and then said: "I think you are right. We will have to look for the right man."

The engineer was right, and this manager is only one of many who are looking for the right men—not men to run engines and boilers but men to run steam power plants.

Where Current Is Sold for 2½ Cents

A central station notable for economy in space occupied by the apparatus. Plant contains Parsons turbines, centrifugal circulating pumps, motor generators, elevator pumps, etc.

The cooling tower, built according to design recently suggested by J. R. Bibbins, has proved to be efficient.

An ingenious oil storage-tank indicator is described.

The city of San Francisco is blessed, or otherwise, whichever way one looks at the matter, by having several separate public light and power companies, supposedly in active competition. The plant of one of these companies, the Municipal Light and Power Company, is interesting from a mechanical point of view in several particulars. Perhaps it is all the more interesting by reason of the fact that the company sells current at a flat rate of 2½ cents per kilowatt-hour.

The plant is located on Stevenson street, almost directly in back of the Claus Spreckels building, which is on the corner of Market and Third streets, in the heart of the business district of the city. From the consumer's point of view there is but one unfortunate feature about this plant—it is too small. Its total rated capacity is only 2240 kilowatts and its service lines extend for only a few blocks.

From a mechanical standpoint the plant is interesting because of the large amount of apparatus contained within the given area. Fig. 1, showing a general view of the generator section of the plant, serves to illustrate the congested conditions. Fig. 2 is a plan view showing the location of the main pieces of apparatus.

The plant contains three Westinghouse-Parsons turbo-generators; two are of 650 kilowatts and one is of 940 kilowatts rated capacity. All three units run at 3600 revolutions per minute and generate current at 2300 volts. The current is transmitted at this voltage and stepped down at destination to 240 and 120 volts.

The two small machines have one Worthington surface condenser each, containing 2818 square feet of condensing surface. The wet-vacuum pumps, one for each unit, are of the Blake "Featherweight" simplex type, 7½ by 14 by 10 inches in size; there are no dry-vacuum pumps.

The condenser for the large machine is a Wheeler, containing 4107 square feet of condensing surface and equipped with a 10 by 20 by 16-inch Blake, "Featherweight" simplex wet-vacuum pump and a 10 by 20-inch "Rotrex" dry-vacuum pump, chain driven by a 6½-horsepower motor.

Cooling Tower

As the Municipal Company's plant is located too far from the waterfront for sea water to be available for condensing purposes, fresh water is used, recooled in a cooling tower. A forced-draft type of tower was erected for these reasons: the forced-draft type loses no water through windage, which is a point in its favor where water is costly; the forced-draft tower is less bulky than the natural-draft or atmospheric types, hence it is cheaper to build and requires less foundation area. A point which is sometimes against it is the fact that it requires power to run the blast fan. In the present instance this point counts for practically nothing, because the fan is steam-engine driven and the exhaust from the engine is sold for heating purposes.

The tower originally installed did not prove to be adequate and a new tower, of different design, has recently been built. With the old tower it was difficult to get a vacuum better than 23 or 24 inches; with the new one 28½ inches are frequently obtained. The old tower was filled with sets of horizontal wooden gratings and the air blast was supplied by the large disk fan shown in Fig. 3. The chimney for this tower is the large circular steel stack shown at the left in Fig. 4. Two faults were discovered after the tower was put into operation. The arrangement of the gratings did not divide the water into fine enough particles to produce good cooling effect. And the fan was not of the proper type to operate successfully against the friction head of the tower and furnish the required volume of air.

The second tower is the rectangular corrugated sheet-iron structure seen in Fig. 4. This tower is filled with tiers of very nearly vertical wood-lath mats in the manner and of the design suggested by J. R. Bibbins in a paper presented to the American Society of Mechanical Engineers about two years ago, an abstract of which was printed in POWER for January 18, 1910.

FIG. 1. PART OF THE EQUIPMENT OF THE MUNICIPAL PLANT

The fan which furnishes the air blast for the new tower is of the Sirocco type and was furnished by the American Blower Company. It has an 8 by 8-foot runner, double inlet, and a 64-by 128-inch outlet. Under normal operation the fan makes 55 revolutions per minute and delivers about 92,000 cubic feet of air per minute against a head of ¼ inch, water gage.

Circulating-water Pumps

There are three circulating water pumps of the centrifugal type, 10 inches in size. Two of these are direct driven by 50-horsepower induction motors and the third is driven by a 75-horsepower motor, all run at a speed of 850 revolutions per minute. The piping is so arranged and bypassed that any combination of pumps may be used.

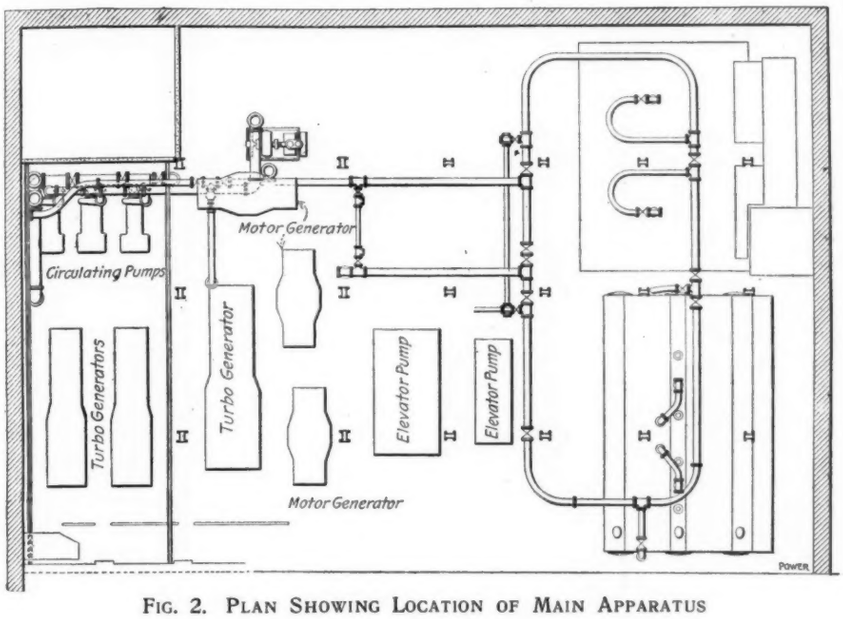


Fig. 2. Plan Showing Location of Main Apparatus

Boilers

The boiler equipment consists of four specially constructed Stirling boilers, specially constructed to accommodate the small amount of head room available. One is of 350 horsepower rated capacity and the other three are of 450. Two of the larger boilers have superheaters which effect a superheat of 50 degrees. Steam is generated at 170 pounds pressure, gage.

As in almost every steam plant in California, the fuel is crude oil. This is stored in three tanks of 110 gallons capacity each, buried 2 feet below the grate level as prescribed by city ordinance.

The oil is pumped to the burners by a 6x4x6-inch duplex pump, through a tubular heater in which it is heated to a temperature of about 150 degrees. The oil-pumping equipment is in duplicate.

The oil pressure is regulated by a Witt pump governor which is set for a pressure of 50 pounds per square inch. The steam used by the burners is superheated by being passed through a loop of steam pipe which is hung on the inside face of the front wall of the boiler furnace. The supply of steam to the burners is regulated by hand. Hammel back-shot burners are used in Hammel furnaces. The small boiler has three burners and the large boilers have four each.

Oil-storage Tank Indicator

An ingenious arrangement for ascertaining the quantity of oil in the storage tanks has been devised by the chief engineer. It is illustrated diagrammatically in Fig. 5. A homemade glass U-tube of suitable size is mounted on the board *A*. A ⅛-inch wrought-iron pipe is connected to one leg of the tube and run to the bottom of the storage tank as shown. Anywhere between the U-tube and the tank a pipe connection is made with the compressed-air system.

By opening the valve of the compressed-air pipe a very slight amount, the air pressure in pipe *B* gradually builds up until all of the oil is forced out at the lower end and air beings to escape up through the oil. Of course, there must be nothing but atmospheric pressure in the oil tank. The air pressure in *B* also displaces the mercury in the U-tube, the amount depending on the depth of the oil in the storage tank, the displaced mercury being balanced, so to speak, by the displaced oil. Thus the scale on the board behind the U-tube may be graduated in barrels of oil and the amount on hand may be ascertained at a glance. The accuracy of this arangement depends on the pipe *B* and its connections being air tight.

This same principle may be applied equally well to water-storage tanks, etc.

The three motor-generator sets shown in Figs. 1 and 2 are used for electric-elevator service exclusively. They generate direct current at 250 volts. Two are of 150 kilowatts capacity and one is of 300.

Elevator Pumps

The plant contains two hydraulic-elevator pumps. The larger one is a rebuilt compound duplex pump, the water end of which once belonged to a Crane crank-and-flywheel type. The steam end of the original machine was removed and a new steam end, furnished by the George Dow Pump Company, was put on. The sizes of the original steam cylinders were 16 and 20 inches in diameter and 16 inches long. The new steam cylinders are 12 and 20 inches in diameter with an 18-inch stroke; the water cylinders are 8 inches in diameter. The clearance which existed with the old machine made it possible to increase the stroke from 16 to 18 inches with very little alteration to the water cylinders.

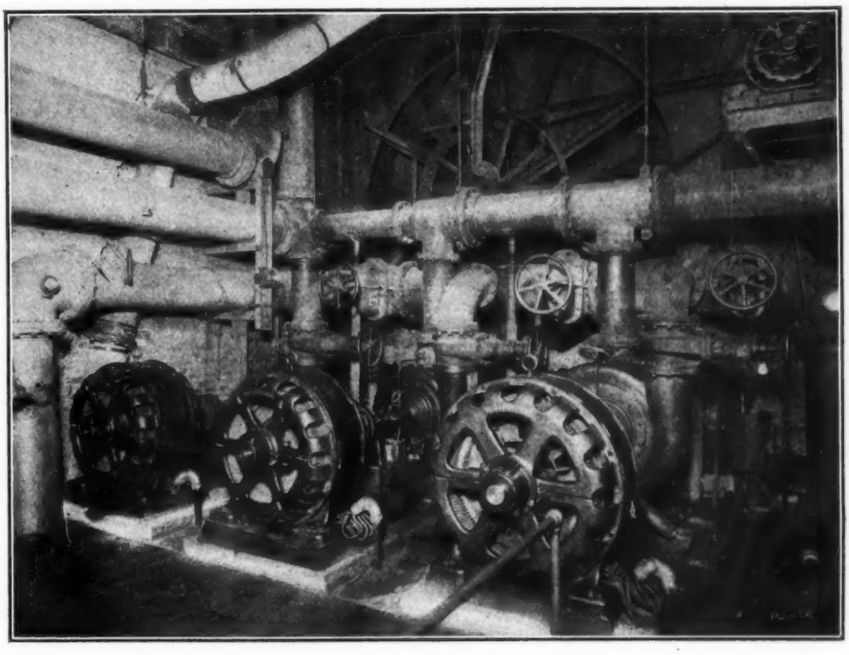


Fig. 3. The Circulating Pumps

This pump handles about 53,000 cubic feet of water per day of eight hours against a pressure of about 275 pounds.

The other pump is a Worthington compound duplex, 16 and 22 by 8½ by 12 inches in size. It is used on Sundays and holidays and in emergency. These pumps operate the elevators in the Spreckels building, across the street.

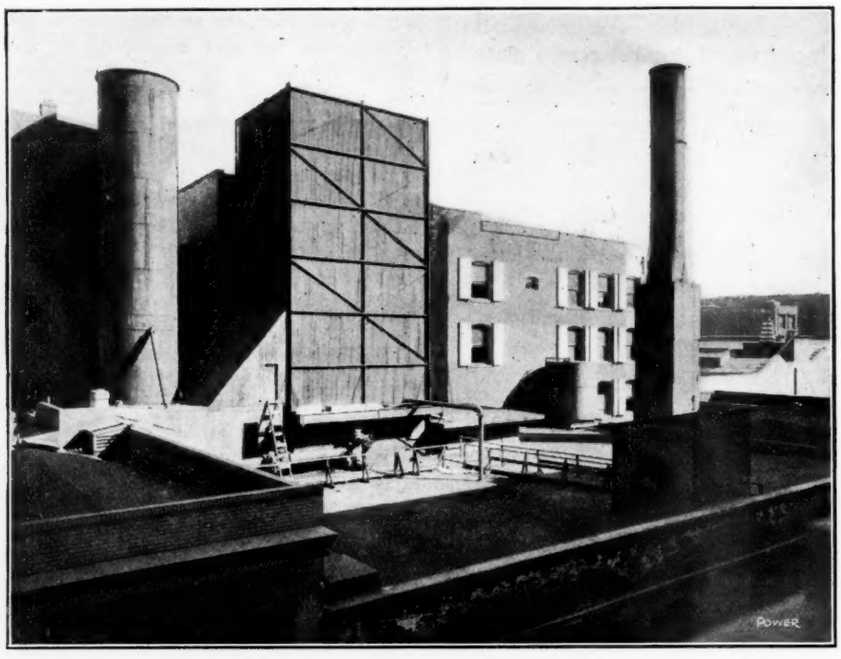


FIG. 4. OLD AND NEW COOLING-TOWER STACKS

EXHAUST-STEAM HEATING

Although the heating requirements of the climate of San Francisco are not severe, the season is a rather long one. Hence, exhaust-steam heating is profitable. All of the exhaust from the steam auxiliaries is sold during a large part of the year to heat nearby office buildings.

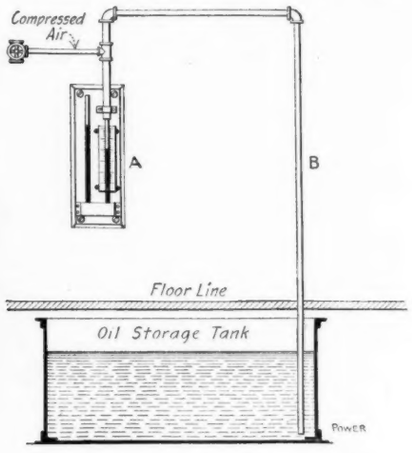


FIG. 5. OIL-STORAGE TANK INDICATOR

Test of World's Largest Boilers

The November *Journal* of the American Society of Mechanical Engineers contains a paper by D. S. Jacobus upon the tests of the large Stirling boilers at the Delray station of the Detroit Edison Company. These boilers are the largest in the world and it is planned to eventually install ten at this station. The first of these has now been in service for 18 months, the second and third for nine months and two more are being erected.

Results of a series of tests on the Stirling boilers at the Delray station of the Detroit Edison Company, which carry individual loads equivalent to 8000 kilowatts.

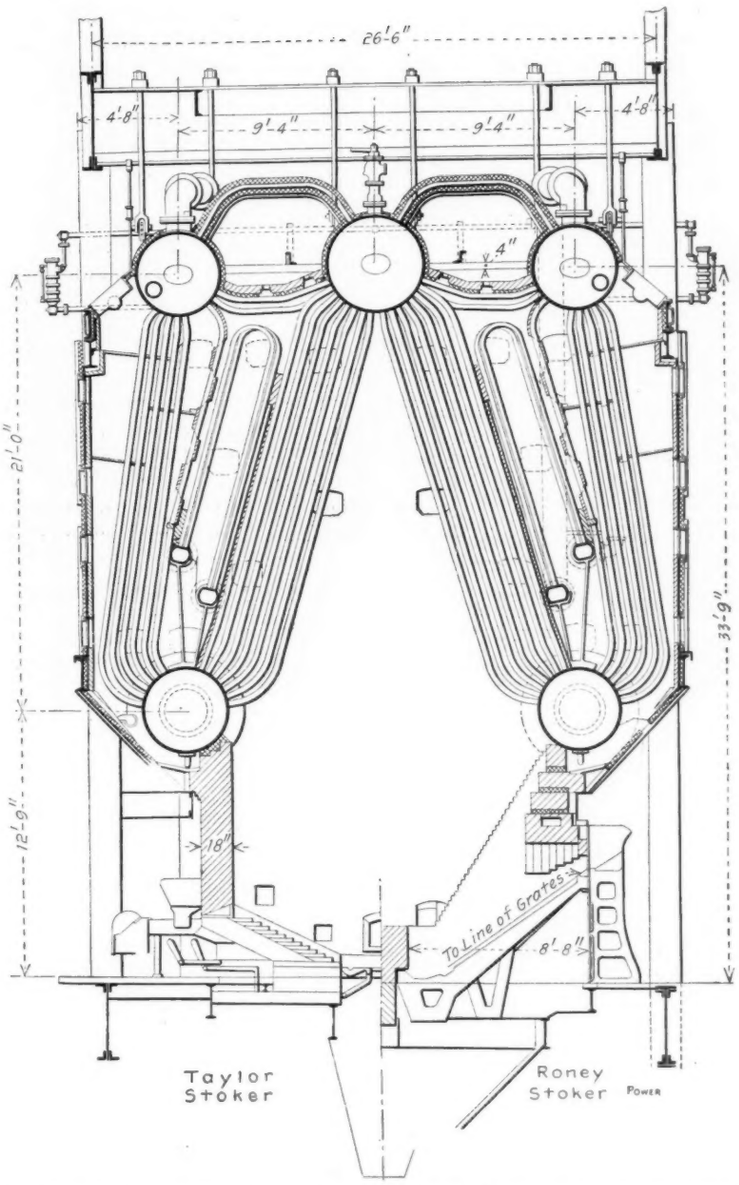
A detailed description of these boilers was given in the October 11, 1910, issue of POWER, but at that time data were not available as to the actual performance. The tests described by Mr. Jacobus extended over a period of three months and were made under his direct supervision by a staff of experts from the engineering department of the Babcock & Wilcox company.

Two series of tests were made, one

TABLE 1. TEST WITH RONEY STOKERS

Test number	Duration of trial, hours	Steam pressure leaving superheater	Average Draft, Inches of Water			Temperature, Degrees Fahrenheit					Dry coal per hour per square foot of grate, pounds	Steam used by stoker engines, per cent. of total steam	Steam used by jets, per cent. of total steam	Equivalent evaporation from and at 212 deg. F. per lb. of dry coal	Equivalent evaporation per hour from and at 212 deg. F. per sq. ft. of boiler heating surface	Boiler horsepower developed	Per cent. of rated horsepower developed	Combined efficiency of boiler and furnace
			Below the two dampers	In furnace	In ashpit	Superheat	Feed water entering boiler	Gases leaving boiler	Gases entering rear bank of tubes	Gases below damper								
1	25	190	0.42	0.32	0.16	135.3	184	576	903	602	16.73	0 15		11.52	3 63	2491	105.0	77.84
2	24	188	0.05	0.16	0.06	115.2	180	480	851	479	12.58	0.18		11.71	2.78	1903	80.0	79.88
3	24	192	0.51	0.39	0.21	130.5	184	542	992	565	18.23	0.16	0.47	11.42	3.92	2691	113.8	77.45
4	30	192	0.55	0.22	0.02	136.4	181	670	1064	709	25.97	0.15	1.43	10.74	5.26	3606	152.4	75.78
5	24	187	0.16	0.24	0.10	107.5	183	483	847	501	14.81	0.19	1.56	11.62	3.24	2225	94.0	81.15
6	24	191	0.57	0.26	0.16	136.8	185	662	1085	668	25.32	0.11	1.34	10.89	5.20	3565	150.7	75.28
16	32	188	0.17	0.23	0.12	102.1	177	460	678	467	14.92	0.18	1.16	12.08	3.40	2333	98.6	80.98
17	16.5	194	0.95	0.34	0.06	132.6	179	636	927	622	30.85	0.15	1.24	11.46	6.67	4572	193.3	76.73
18	24	194	1.11	0.33	0.05	157.6	178	694	1029	709	33.60	0.13	1.19	10.66	6.75	4630	195.7	75.57
2–4*	90	191	0.38	0.28	0.06	130.9	182	572			19.81	0.15		11.06	4.13	2833	119.8	76.13
5–6*	55	189	0.38	0.25	0.05	125.7	183	575			21.21	0.14		10.98	4.39	3012	127.3	76.23

*Includes periods between tests.



SECTION THROUGH BOILER, SHOWING BOTH TAYLOR AND RONEY STOKERS

on a boiler fitted with Roney stokers, and the other on a boiler fitted with Taylor stokers. The boilers are double ended and to avoid unnecessary duplication in the accompanying illustration, one end is shown with Roney stokers and the other with Taylor stokers; but it should be remembered that both ends are alike in the actual installation.

In the boiler fitted with Roney stokers, four are used—two at the front and two at the rear with a low division wall between the stokers and a bridgewall between the two sets. The Taylor stokers have 13 retorts on each end, or 26 in all. The retorts on each end are set in a continuous row so as to provide an unbroken fire surface from one side of the boiler to the other. With these stokers there is no bridgewall, and when the dumping plates are covered with coal there is a continuous fuel bed beneath the entire boiler.

Giving a general résumé of the principal features of the boilers as contained in our previous description, each boiler is 30 feet 6 inches wide, 26 feet 6 inches deep and stands 33 feet 9 inches from the floor to the center line of the drums. It contains 23,654 square feet of effective heating surface and is provided with superheaters for supplying steam at 150 degrees superheat. The grate surface per boiler for the Roney stokers is 446 square feet and for the Taylor stokers, 405 square feet, thus giving as ratios of grate surface to heating surface, 1:53 and 1:58½ respectively.

Table 1 shows the results of the tests with Roney stokers and Table 2 with Taylor stokers. It will be seen from these tables that the combined efficiency of the boiler and furnace varied from about 80 per cent. at slightly below rating to about 76 per cent. at double the rating. In calculating these efficiencies the steam used for driving the stokers and for producing the forced blast for

TABLE 2. RESULTS WITH TAYLOR STOKERS

Test number	Duration of test, hours	Steam pressure leaving superheater, pounds gage	Draft, Inches of Water		Temperature Degrees Fahrenheit					Dry coal per sq.ft. of grate surface per hour, pounds	Equivalent evaporation from 212 deg. per pound of dry coal	Equivalent evaporation from 212 deg. per sq.ft. of heating surface per hour	Boiler horsepower developed	Per cent. of rated horsepower developed	Efficiency of boiler and furnace	Steam used by stoker engines and turbines driving fans, per cent. of total steam
			Below dampers	In ashpit	Superheat	Feed water	Gases leaving boiler	Gases entering rear bank of tubes	Gases below damper							
7	24	193	0.58	0.03	155	187	575	959	539	27.39	11.12	5.22	3577	151.2	77.07	2.61
8	24	192	0.20	0.11	128	181	493	748	466	18.82	11.55	3.72	2553	107.9	80.28	2.44
9	50	192	0.53	0.06	156	184	574	934	549	29.23	11.23	5.62	3853	162.8	77.85	2.87
10-A	24	191	0.20	0.15	133	188	489	732	465	16.63	11.40	3.25	2226	94.4	77.63	2.64
10	48	190	0.20	0.15	134	187	487	756	460	16.43	11.39	3.22	2197	92.9	77.90	2.63
11-A	12	188	0.83	0.03	166	186	668	1045	626	39.27	11.03	7.41	5083	214.8	76.18	3.66
11	26.5	190	0.84	0.02	165	188	651	1027	611	38.75	10.99	7.29	4999	211.3	75.84	3.41
12-A	24	189	0.24	0.08	133	177	514	789	470	20.59	11.45	4.04	2768	117.0	79.21	2.52
12-B	24	190	0.27	0.02	139	182	555	844	500	22.14	11.42	4.33	2968	125.5	79.19	2.62
12	48	189	0.26	0.05	137	179	535	816	484	21.37	11.44	4.18	2870	121.3	79.24	2.57
13	11.5	178	0.85	....	166	178	641	987	584	36.91	11.09	7.01	4807	203.2	76.56	3.29
14	24	189	0.84	0.20	168	177	647	994	598	33.25	11.24	6.40	4390	185.5	76.42	2.95
15	24	188	0.57	....	145	176	561	976	510	22.61	19.97	4.23	2912	123.1	74.90	2.77
7-9	109	192	0.45	....	147	184	545	...	...	25.21	11.19	4.83	3312	140.0	77.66	2.68
10-11	80.5	190	0.44	....	144	187	542	...	...	24.36	10.99	4.58	3143	132.8	75.66	3.04

the Taylor stokers was not deducted from the total steam generated by the boiler. The steam used by the Roney stokers was about 1½ per cent. of the total steam generated by the boiler and for the Taylor stokers from 2½ to 3 per cent. The effect that this steam would have on the plant economy depends upon the ability to use the exhaust for heating the feed water. In the case of the Taylor stokers all of the exhaust steam from the turbines driving the forced-blast fans may be carried to the feed-water heater, whereas with the Roney stokers only about ⅓ of 1 per cent. of the 1½ per cent. used may be so returned as the greater part of the steam is used in jets which supply steam below the ignition arches of the stokers, and therefore passes away with the chimney products. In a plant in which the auxiliaries are electrically driven, any power required to operate the forced-blast apparatus would be a direct loss and, assuming in the case of the Taylor stoker that the steam consumption corresponding to the power required to drive the electrical-driven auxiliaries is one-half that found in the tests, the steam required to operate each of the stokers would be about the same.

The results of the heat balances show that the average radiation and unaccounted-for losses were only about 2½ to 3 per cent.

Although the tests show a maximum of about 5000 boiler horsepower, it is stated in Mr. Jacobus' paper that each of these boilers is required in all-day service to carry a load of 6000 kilowatts and in the evening from 7000 to 8000 kilowatts.

Effect of Air Pressure

By Charles R. Moore

It is a matter of experience that air exerts a pressure of 14.7 pounds per square inch at sea level and that this pressure diminishes as the hight above sea level increases. This pressure may be easily measured by noting the hight of a column of mercury in a glass tube sealed at the top and open at the bottom, which has been previously filled with the liquid and inverted in a vessel containing a small amount of the mercury. This instrument is commonly known as the barometer. Of course, the hight to be measured is the distance between the mercury levels. A knowledge of the density or specific gravity of mercury enables one to convert this dimension into pounds per square inch. A fact not commonly noticed in connection with this instrument is that a collapsing force is exerted on the tube, which varies in intensity directly as the hight of the mercury. This means that each area on the tube at the top of the column, equal to the cross-sectional area of the column, has a force inward exerted upon it equal to the entire weight of the suspended mercury.

Water may be used instead of mercury, but a tube very much longer must be had. As is well known, the mercury column will be normally about 30 inches, while a water column would be about 34 feet in length. If a tube shorter than 34 feet be used, it will stand full, and the inward pressure at the top will be the same fractional part of 14.7 pounds per square inch that the length of tube is of 34 feet. Thus the pressure exerted by a water column 10 feet long would be approximately

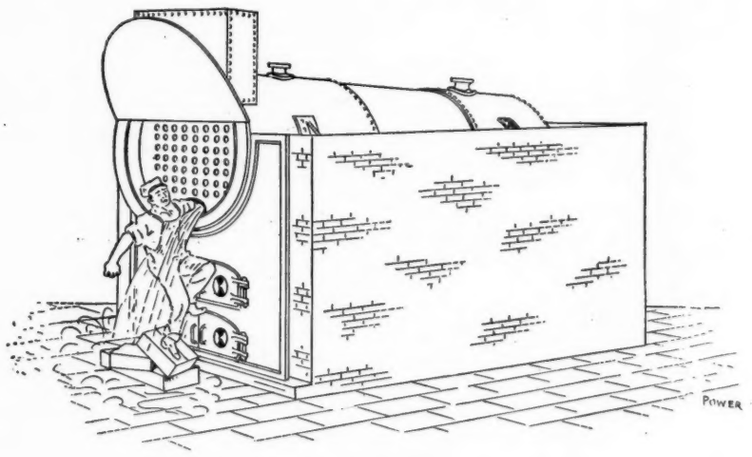
$$\frac{10}{34} \times 14.7 = 4.32 \text{ pounds per square inch}$$

In case a tube longer than 30 inches for mercury and longer than 34 feet for water is used, the liquids fall to the levels before mentioned and a vacuum exists in the upper part of the tube. The maximum inward collapsible pressure, therefore, which can be produced by this means is 14.7 pounds per square inch. Engineers as a rule have a keen appreciation of this fact, but occasionally one is found who, if he really knows why a pump can lift water, is more or less careless in his reckoning with this particular circumstance. Such persons usually come to grief sooner or later, as the following incident will show:

John had charge of the power end of a small factory and was proud of the fact that he had been more or less successful in keeping up his part of the work without paying very much attention to theory. He had received his training in the school of hard knocks and had studied his engines and boilers carefully in regard to their practical operation. "How to do things" interested him immensely. Adjustments, filing, alining, etc., were his particular delight, but when anyone began to talk angles, velocity of gases in stacks, combustion, inches of draft, etc., he evinced but little interest. John seemed to have a special aversion to air pressure, and cared but little why the water came up into the feed pump, so long as he knew the details of how to make it come and how to keep the boilers full.

The writer visited his plant one Sunday afternoon just as he had finished cleaning one of the boilers. This of the tubular type, and had been set rather high in the brickwork, from one side of which the blowoff pipe was led to a drain tile some feet below the floor level. The mud valve was placed just below the ell and further down a stop valve was located.

As usual in this type of boiler, there were two manholes, one at each end in the flue sheets. The rear one was near the top and the front one close to the bottom of the shell. To get at the front head the breeching door had to be raised



The Suction Drew His Arm into the Manhole

and John had fixed up a pile of small boxes in front of the fire doors on which to stand.

When I accosted him, he was mounted on this improvised pedestal examining the manhole plate seriously. "Anything wrong?" I asked. "No," said John, "but the boss will not give me anything but hemp from which to make gaskets and I am likely to have a leaky joint here. Sometimes I get a good fit, but just as often the job has to be done the second time."

"Ever try plumbago and oil on your hemp?" I asked.

"Yes, I have used oil on this one, and cylinder oil at that, but it is leaking like a sieve. I just now shut the boiler up tight with the water at about one gage, thinking that when the feed pump stopped the joint would be driven up so tight it could not leak, but it has made matters worse."

Sure enough, the leak was too serious to pass unnoticed, and we both decided that a new gasket must be made. John accordingly opened the blowoff valves, and the kicking of the feed pump reminded

him that it had not yet been shut off, even though it had stopped.

"Better open up the gage cocks to let in a little air. Maybe the boiler will drain faster," said I.

"Now do not give me another air-pressure lecture," said John in a frame of mind none too pleasant. "I guess the water can get out of that 2½-inch pipe all right. If it does not, it will come out when I knock the head in." And away he went to prepare another gasket.

I plaited four good-sized strands of hemp fiber for him, and in a short time we stepped outside to see if the boiler had drained. No water was flowing except a slight trickling and John remarked, "That water got out mighty quick."

"May be, it is not all out," said I. John looked at me astonished.

"Why, the valves are wide open," said he, and with that he hurried to the boiler room and mounted his pile of boxes. A monkey wrench was lying inside the breeching, and, grasping the manhole plate by means of the small eye arch cast for that purpose, John began tapping the rim flange with the wrench. He struck perhaps three blows when suddenly he was pulled head and shoulders against the flue ends. His feet swung clear of the boxes and his arm was full length inside the boiler.

He let go of the plate, missed the boxes and fell in a heap directly in front of the boiler, only to receive a deluge of water. He fully realized that the joke was on him, and after things were righted, his clothes changed and a good fire going under the boiler, he turned to me with the inquiry: "Say, would you mind helping me figure out exactly what gave me that baptism?"

After explaining to him such things as have been stated at the beginning of this story, we estimated that the distance from the manhole center to the blowoff valve was 4 feet. Using this as the hight of the water column we figured as follows: The manhole plate was practically a 9x14-inch ellipse, the area of which was approximately 99 square inches. The difference in pressure between the outside and the inside of the manhole was therefore

$$99 \times 1.74 = 172 \textit{ pounds}$$

at the time he broke the joint. It was this which drew the cover in and jammed him against the flue sheet.

Marine Turbine-Engine Installation

A tentative arrangement for marine practice with one reciprocating engine on the center shaft exhausting at about 30 pounds absolute into turbines driving the outboard shafts.

G. W. Dickie, in a paper read before the Society of Naval Architects and Marine Engineers, at New York, on November 16, outlined an interesting arrangement of combined reciprocating and turbine engines for marine work. Although at variance with the practice of some prominent engineers in this line, the arguments supporting this arrangement appear logical.

Speaking of the limitations of both types, Mr. Dickie points out that the turbine begins its work in the wasteful end and finishes in the economical end, whereas in the reciprocating engine this is reversed. In the case of the latter the chief loss is due to the alternate heating and cooling of the cylinders caused by the drop in temperature as the steam expands, the difference in temperature being much greater in the low-pressure than in the high-pressure end, and the consequent condensation due to the heat abstracted from the steam to replace that lost in the low-pressure cylinder during the exhaust stroke.

The turbine escapes this loss because the steam is continually moving in one direction on its way to the condenser and the rotor maintains a temperature which corresponds with that of the steam at any point in its passage. Mechanically, however, the turbine is defective, as a certain amount of clearance must be allowed between the tips of the rotor blades and the casing and also between the tips of the guide blades and the rotor. As these blades, at the high-pressure end, are very short and the clearance has to be as great there as elsewhere, the free passage for steam at this end is considerable, especially in the marine type where the rotors are of greater diameter and the area of the clearance correspondingly greater. Where the blade is only about one inch in length and with, say, 0.05 inch or 0.06 inch clearance, there is over 10 per cent. of clear space for the steam to pass without doing work. At the low-pressure end, however, where the blades may be 10 inches long, the same clearance would be only 1 per cent.

The arrangement which has found favor with those responsible for the most important installations of power on board ship, where the two types of engine have been combined, has been that in which the steam has been expanded in the reciprocating engine down to a pressure of 9 or 10 pounds absolute. This would give a drop in temperature in the low-pressure cylinder of about 62 degrees—say a mean of 31 degrees below the temperature of the entering steam. This is far below the line where the economy of the turbine is superior to that of the reciprocating engine and is undoubtedly the result of accepting as best the arrangement of two sets of reciprocating engines and one exhaust turbine between, the new White Star liners being notable examples of this arrangement. For very large installations there are several important advantages afforded by this arrangement: the size of the reciprocating engines is thus kept within reasonable limits; the manœuvering power is 80 per cent. of the total; a breakdown of the turbine engine leaves the whole manœuvering power intact, while a breakdown in one of the reciprocating engines still leaves 75 per cent. of the propelling power intact and 40 per cent. of the manœuvering power available. There would also be what advantage can be claimed for twin screws for manœuvering.

Notwithstanding these important advantages claimed for the arrangement of two reciprocating engines and one turbine, Mr. Dickie believes that better results, with installations up to 20,000 horsepower, can be secured by having one reciprocating engine on the center line delivering steam to a turbine on each side at about 30 pounds absolute. This would admit of the center-line engine developing about 40 per cent. of the total power and, when exhausting straight to the condenser, at least 60 per cent. of the full power. The larger and most effective propeller would be on the center line, where its efficiency would have the best propelling effect. The smaller side propellers would not require as wide projections from the side of the ship and would thus cause less disturbance to the water in the after run. With the large propeller in the center, the side propellers could be run at a greater number of revolutions than would be advisable for the center propeller were it turbine driven. This would permit of the turbine rotors and casings being of a moderate diameter. In a 20,000-horsepower set of engines, with the center-line shaft making, say, 78 revolutions, the side shafts could be run at about 400 revolutions which would give a diameter of about 8 feet to the rotor. This would enable the turbines to be placed alongside the reciprocating engine in any merchant ship having that amount of power.

With the reciprocating engine closing its work with a terminal pressure of 30 pounds absolute, a simple compound en-

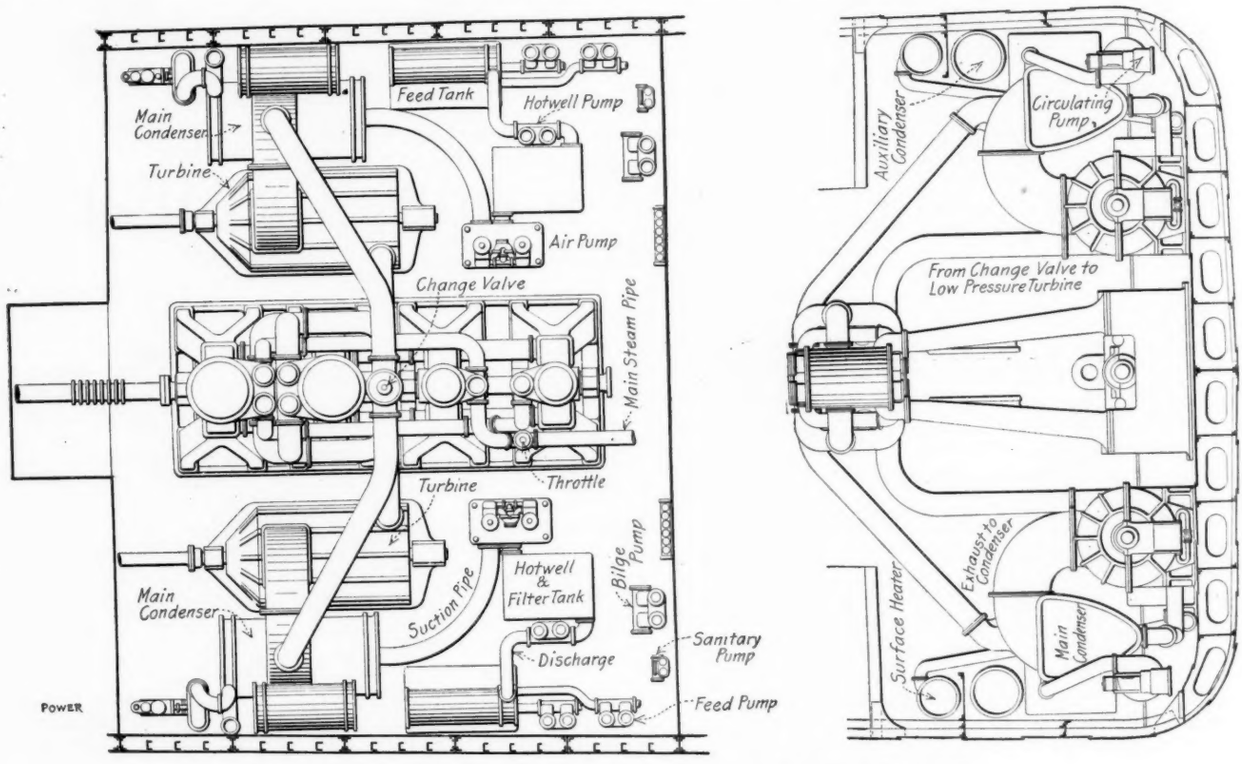
gine would give satisfactory results. Where the total power was to be above 8000 horsepower, it would seem advisable to make the reciprocating engine with two high- and two low-pressure cylinders, the high-pressure cranks being 180 degrees apart and the low-pressure cranks 180 degrees apart, each pair being 90 degrees apart; this would produce a well balanced engine. By a proper arrangement of exhaust from the low-pressure cylinders, only one change valve would be necessary. This would be operated by a direct steam cylinder, controlled by a hydraulic cylinder and piston so that the movement might be as slow as required. No steam jackets would be needed on the cylinders. The exhaust pipes, however, from the low-pressure cylinders to the turbines, might be jacketed to advantage.

In such an arrangement there need be no objection to operating the air pumps, of which there would be two, through levers worked from the crossheads of the low-pressure cylinders. These would be placed so that the foot valves would be as low as possible, the channel way being in line with the lower face of the bedplate so as to be below the lowest part of the turbine casings, it being important to have them thoroughly drained. The dry-air pumps should be operated in the same manner as the wet-air pumps, being placed above the operating levers in a direct line with the wet pumps. The feed pumps would be operated independently and thus remove another source of trouble from the main engine. In nearly all cases there would be room to install the main condensers on the outboard side of the turbines, so placed as to have the exhaust passage in the middle of the condenser. The channel ways or connections to the wet-air pumps would pass through the lower part of the turbine casings and connect direct to the lower chambers of the pumps. As the turbines would not be as long fore and aft as the reciprocating engine, there would be plenty of room for all engine-room auxiliaries.

An objection which might be raised to the arrangement advocated, is that a breakdown of the reciprocating engine would deprive the ship of backing power. This objection is admitted, yet from the simple construction of the proposed reciprocating engine a breakdown involving the stopping of the engines for good seems rather a remote possibility and, if it should happen, the turbines could keep the vessel going ahead.

If right in the claim that the turbine can show a higher efficiency than the reciprocating engine to a point much higher in the expansion curve than 9 or 10 pounds absolute, then the arrangement Mr. Dickie proposes would give a better combined economical result and be simpler and less expensive.

In utilizing the expansion in reciprocating engines down to a pressure of, say, 9 pounds absolute, cylinders of large dimensions must be provided subject to marked changes in temperature at every revolution, involving large losses due to condensation combined with large frictional losses causing a great curtailment in the theoretical gain due to the expansion; on the other hand, by delivering the steam to the turbines at a pressure and temperature that insure a more economical continuation of efficiency in the power developed, the best performance is obtained with each type of engine.



ARRANGEMENT OF HIGH-PRESSURE ENGINE AND LOW-PRESSURE TURBINES

According to Alfred C. Lane, formerly State geologist of Michigan, there are seven horizons at which the coal occurs in workable thickness, although it was formerly supposed that there was only one workable bed in the State. The coalfields of Michigan are confined entirely to the lower peninsula, with an area of approximately 11,000 square miles. This is the only known coalfield within the drainage area of the Great Lakes. Michigan's original supply of coal, according to the estimate of M. R. Campbell, of the United States Geological Survey, was 12,000,000,000 tons, contained in an area of 11,000 square miles of coal-productive territory.

Iowa probably ranks second among the States west of Mississippi river in order of priority as a coal producer. Its production to the close of 1910 amounting to nearly 164,500,000 short tons. The original supply of coal in Iowa, as estimated by M. R. Campbell, of the United States Geological Survey, was 29,160,000,000 short tons, from which it appears that at the close of 1910 over 28,900,000,000 short tons.

Strain Measurements of Boilers

Two 72-inch boilers were tested to destruction by subjecting them to hydraulic pressure.

At 266 pounds the dome of the first boiler leaked so badly that it had to be removed; at 270 pounds the cast-iron manhole frame fractured, and at 295 pounds the bracing of the head gave out.

The second boiler was reduced as nearly as possible to a simple cylinder before the test commenced, by the removal of the dome and manhole frame, but at 335 pounds the rivets of the patch with which the manhole was covered sheared, allowing the boiler shell to rupture.

It is rarely that one gets a 72-inch boiler to test to destruction. Two such boilers which had been in active operation for 27 years were contributed for investigative purposes by the late Nicholas Sheldon, treasurer of the Kendall Manufacturing Company, of Providence, R. I. They were made by the Whittier Machine Company, of Boston, Mass., out of "Benzon" steel, were put into service in March, 1881, and had never required repair or renewal in any part. They were made in five courses, two sheets to a course, and had the following general dimensions:

Diameter	72 in.
Length, over dry sheet	16 ft.
Thickness of shell	3/8 in.
Thickness of heads	1/2 in.
Number of tubes	140
Diameter of tubes	3 in.
Length of tubes	15 ft.
Diameter of dome	2 ft. 6 in.

Longitudinal seams, double-riveted lap joints, 3/4-inch rivets, 2-inch pitch, punched holes, rows 2 1/16 inches apart, rivets staggered.
Girth seam, 3/4-inch rivets, 2 1/8-inch pitch.
Heads stayed, each, with 14 braces.
Cast-iron manhole frames and safety-valve nozzle.
Supported by lugs, three on a side.
The feed water came from the Pawtucket river.

The utmost advantage of this opportunity was secured by placing in charge of the tests James E. Howard, qualified by long years of service as the head of the Government testing plant, at the Watertown arsenal and now engineer-physicist of the Bureau of Standards, at Washington. He was advised and assisted by Francis B. Allen, vice-president of the Hartford Steam Boiler Inspection and Insurance Company. The tests were made at the W. H. Hicks Boiler Works, Providence, and form the subject of a paper to be presented at the December meeting of the American Society of Mechanical Engineers, from which the following information is derived:

The tests were made by subjecting the boilers to hydrostatic pressure and measuring the deformation at various points. For this purpose holes about 0.05 inch in diameter and 0.10 inch deep were drilled 10 inches apart in various portions of the shell, and reamed with a reamer having an angle of 65 degrees. A 10-inch strain gage having conical points with an angle of 55 degrees, adjustable with a micrometer screw, was used to measure the distances between these holes as they varied under stress. The difference in angles made the gage bear near the surface of the sheet and it is believed that the readings are reliable to $\frac{1}{10,000}$ inch. The stress which would produce an elongation of this amount in a distance of 10 inches is 300 pounds per square inch, assuming a modulus of elasticity of 30,000,000 pounds; that is, supposing that the stress per square inch divided by the stretch per inch of length would equal 30,000,000.

The boilers tested were of a very simple type, yet in very few instances were strains developed corresponding to those which would be indicated by the usual calculation for strains in a cylindrical shell subjected to internal pressure. In Fig. 1 are laid off in a horizontal direction the amounts of stretch which would be produced by various pressures per square inch in a plain cylinder and with a modulus of elasticity of 30,000,000, each at a hight corresponding to the pressure required to produce it. A pressure of 60 pounds per square inch in the interior of a cylinder of this diameter and thickness of shell would, for instance, produce a stretch of nearly 0.0020 inch in a length of 10 inches; and a pressure of 300 pounds a stretch of about 0.0095 inch. The points so determined would lie in the heavy straight line of the diagram marked $E = 30,000,000$. The distortions actually found were set off in the same way and connected by the lighter lines. They show the extensions of the third and fourth sheets of the boiler, counting from the front on the right and left sides of the boiler respectively, taken at the middle of the lengths of the courses. The courses are lettered *A, B, C, D, E; C*—16 R. on the diagram means gaged length 16 on sheet *C*, right-hand side. These follow the heavy reference line for the ideal condition quite closely upon one side of the boiler, but the leaning to the right of the plotted lines of the other diagram indicates more than a normal stretch.

The strains produced at the various places measured are plotted in this way and the diagrams accompany the paper. There were in all 165 gaged lengths and some 3300 readings. In Fig. 2 the lines *E*-12, which are the plots of strains occurring nearly over the rear head, show the effect of the head in preventing stretch of the sheet. *E* is the rear sheet. *E*-8 was taken near the girth seam between this and the next sheet and *E*-16 in the center of the rear sheet close to, but not spanning, the longitudinal joint. Diagrams

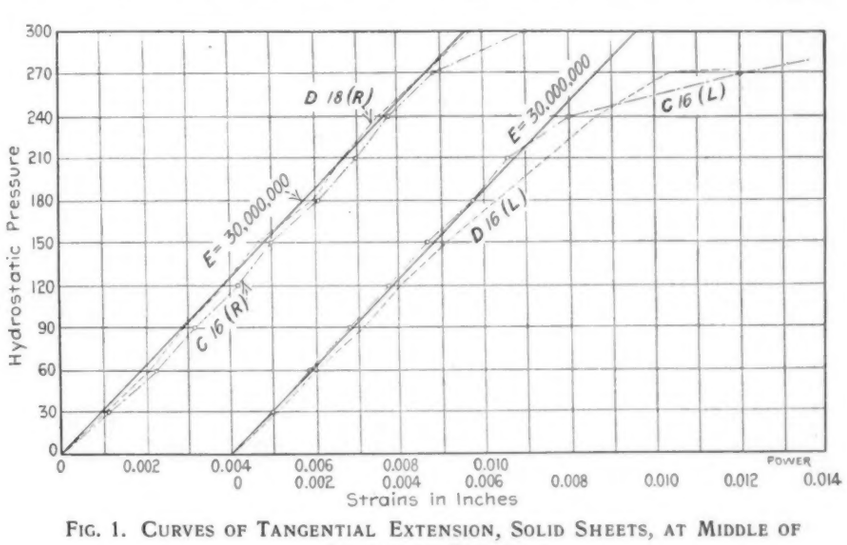


FIG. 1. CURVES OF TANGENTIAL EXTENSION, SOLID SHEETS, AT MIDDLE OF LENGTH OF COURSES

of the boiler are given in the paper showing the location of each of the spans measured. Fig. 3 shows the extension across the longitudinal seam on the middle course, curve *C*-7 being taken at the front edge, *C*-11 at the rear edge and

C-15 in the middle of the sheet. The author points out that in the case of a three-course boiler with one sheet to a course, as found in current construction, it would seem that a double riveted lap joint might occasion (by reason of the greater extension) an excessive stress in the solid sheet abreast the end of the seam, under certain pressures.

Pressure on the exterior of the tubes necessarily extends them in length. The amount of the extension appears to depend upon their position with reference to their proximity to the shell. Tubes adjacent to the shell extend less than those at the middle of the rows, a restraining influence from the shell appearing to affect the outer ones.

In a plain cylindrical shell, increase in diameter would necessarily be attended by a definite amount of endwise contraction, eliminating the effect of pressure on the heads. The tests showed that there were parts of the boiler which were nearly free from longitudinal strains, while there were other places in which the strains were reversed and longitudinal extension shown instead of contraction. Along the lower quarter of the boiler the longitudinal strains were contractions, while along the upper quarter they were in part contractions and in part extensions. Figs. 4 and 5 show the amount and character of these strains at 270 pounds in the middle of the sheets and across the girth seams respectively.

It will be noticed that the lower part of the shell contracted notwithstanding the fact that the tubes were extended by the exterior pressure to which they were subjected. This behavior calls for bending at the flanges of the heads to compensate for the difference of these movements. The six through braces would relieve the shell of a portion of the longitudinal tension coming from the heads in the upper half of the boiler. Longitudinal gaged lengths on the upper part of the shell showed diminished contractions over those observed on the lower portion or displayed strains of extension. On the very top of the boiler the strains were extensions of a pronounced order.

The tests for which the figures and diagrams in the paper are given were made upon only one of the boilers. In the tests of the first boiler greater strains were displayed in the vicinity of the dome and the manhole frame than at other parts of the shell, which resulted in an early failure at these places. Actual rupture of the dome was not accomplished, but leakage along its single-riveted longitudinal seam became so great at 265 pounds that it was necessary to remove the dome and close the opening to it in the shell with a patch in order to reach higher pressures with the pump available.

At 270 pounds the cast-iron manhole frame fractured across the middle of its length. Another patch was then put on the shell covering the manhole and the test resumed, when at 295 pounds the rupture of three braces of the front head occurred. The test was then discontinued and the boiler dismantled. The strain measurements made upon the boiler were of the same order as those reported for the second and the results were similar.

A feature, however, in the test of the first boiler was absent or obscure in that of the second. Measurements of strains across the longitudinal seams increased progressively in passing from the front to the rear end of the boiler. The author says: "While these seams were not directly exposed to the heated gases over the grates, nevertheless it seems probable that a wider range of thermal conditions prevailed in the vicinity of seams at the front end over those at the rear end of the boiler. If such was the case it would aid in explaining the greater slip of the forward seams." Leakage at the longitudinal seams began at 120 pounds and became general at 180, but at this time the slip of the joints had become pronounced and necessarily disturbed the calking.

The second boiler was stripped of its dome and manhole frame and the openings covered with patches before it was tested. The heads were strengthened by means of six 1¼-inch through braces. The cast-iron safety-valve nozzle was allowed to remain in place, but was eventually replaced by a soft patch after 300

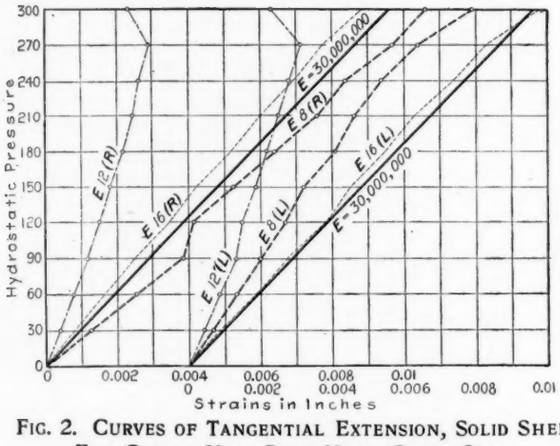


FIG. 2. CURVES OF TANGENTIAL EXTENSION, SOLID SHEETS, END COURSE NEAR REAR HEAD, GIRTH SEAM AND MIDDLE OF LENGTH OF COURSE

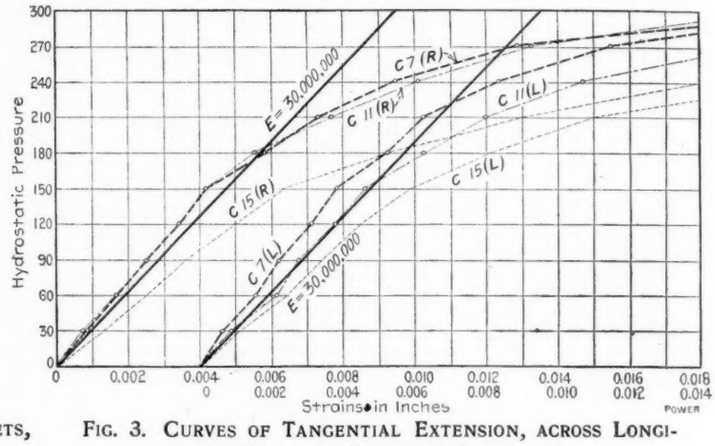


FIG. 3. CURVES OF TANGENTIAL EXTENSION, ACROSS LONGITUDINAL SEAMS, AT MIDDLE OF LENGTH OF COURSE AND AT EDGES

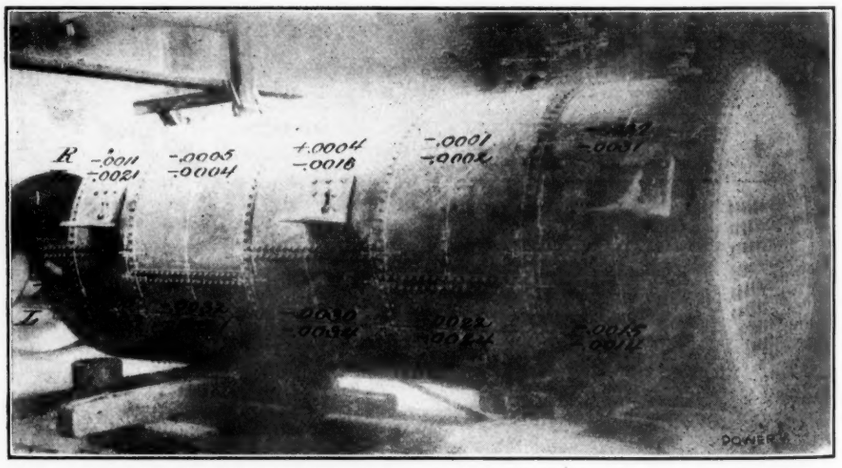


FIG. 4. LONGITUDINAL STRAINS ON SOLID SHEETS AT MIDDLE LENGTH OF COURSES. MINUS SIGNS INDICATE LONGITUDINAL CONTRACTION; PLUS SIGNS, LONGITUDINAL EXTENSION

pounds pressure had been applied and released, as the distortion of the shell under the flange of the nozzle caused leaks impracticable to calk. During the test the boiler was supported on two wooden shoes sawed to fit the curvature of the shell.

When the pressure in the boiler was increased from 300 pounds, the highest indicated on the diagrams, to 335 pounds the manhole patch ruptured. Three of the rivets were sheared by the tangential stress of the shell followed apparently by the fracture of other rivets by tension on their stems which pulled off the heads and finally tore the sheet longitudinally along its upper element, starting this fracture at a rivet hole of the manhole as shown in Fig. 6.

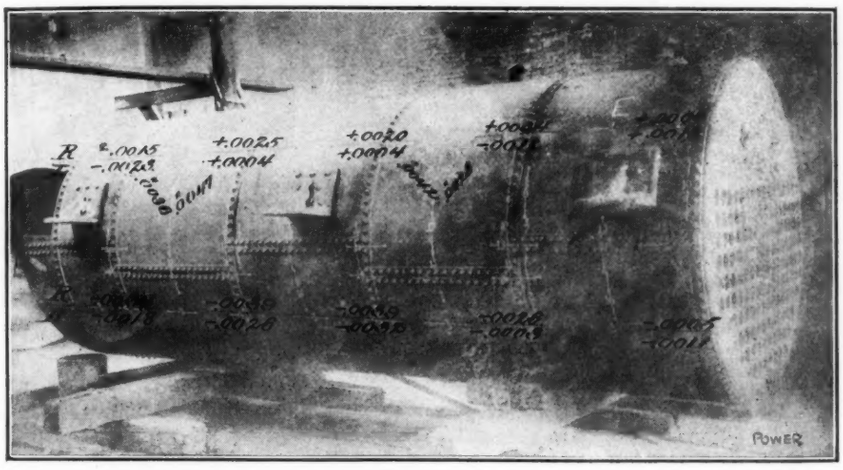


FIG. 5. LONGITUDINAL STRAINS ACROSS GIRTH SEAMS, ALSO STRAINS ON DIAGONAL GAGED LENGTHS OF COURSES

The shell was repaired by cutting out a portion of the middle course and putting in a section the full width of the course and about 3 feet wide measured on the arc. This was double riveted to the shell at its longitudinal seams. The hand-riveted seams extended rapidly, and copious leaks were started so that at the time of writing the paper no greater pressure than that of 335 pounds, at which the manhole patch ruptured, had been attained.

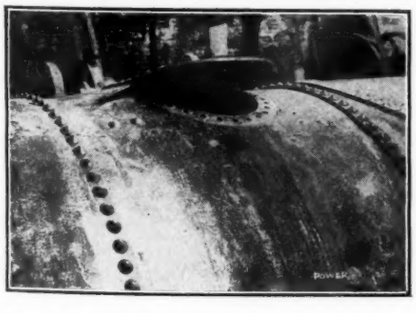


FIG. 6. MANHOLE PATCH AFTER RUPTURE

In summing up, the author points out the usual influence of longitudinal seams in intensifying the stresses in the adjacent sheets, the excessive stress developed at the side of the manhole patch and at the side of the safety-valve nozzle, and suggests that if such abnormal stresses can occur with so simple a structure as the boiler under consideration, it might be well to apply this method of examination to the strains produced in boilers of more complex construction.

CO_2 and Boiler Efficiency

BY E. A. UEHLING

I notice that R. S. Wilhelm, in the article, "Value of CO_2 Recorder," in the October 24 issue, seems to consider that my statement in the August 15 issue, viz: "Since CO_2 by itself is not claimed to be and in the nature of things cannot be a measure of efficiency," is a contradiction of, or at least in conflict with, my previous statement (June 11 issue), viz: "In all cases high or low CO_2 means high or low efficiency," with which latter statement Mr. Wilhelm agrees. These statements are both true and the one in no way conflicts with, much less contradicts, the other.

It will be conceded by all that a reduction in the amount of heat wasted means a corresponding increase in efficiency, and also at any given stack temperature the greater the weight of gas per pound of fuel burned the greater must be the heat wasted up the chimney. Anybody familiar with the process of combustion knows that the lower the percentage of CO_2 the greater is the weight of gas per pound of fuel burned and hence the greater must be the heat wasted up the chimney; and conversely the higher the percentage of CO_2, within the limits of complete combustion, the less the weight of gas, and hence the less the loss, and therefore high CO_2 should and does mean high efficiency and low CO_2 means low efficiency. From this, however, it does not follow that CO_2 is a measure of boiler efficiency any more than vacuum is a measure of engine efficiency; none the less, high vacuum means high efficiency and low vacuum means low efficiency. Nor does it follow from this that one engine running under a vacuum of 22 inches may not show a higher efficiency than another engine running under 26 inches of vacuum, or that one boiler with an average of 10 per cent. of CO_2 in the flue gas may not show a higher efficiency than another boiler with an average of 12 per cent. of CO_2 in the flue gas. As maximum vacuum means minimum waste of power due to back pressure, so maximum CO_2, consistent with complete combustion, means minimum waste of heat up the chimney; neither by itself is a measure of efficiency; both are important factors in attaining and maintaining efficiency. By means of the vacuum gage one keeps tabs on the spigot, while by means of the CO_2 recorder the bunghole is controlled. For example, if the boilers are working with an efficiency of 65 per cent., the engine is using 85 per cent. of the steam generated and the engine efficiency is improved 5 per cent., a saving is effected of 5 per cent. of 85 per cent. of 65 per cent. = 2.76 per cent. on the coal used, whereas if the boiler efficiency is increased 5 per cent. by means of higher CO_2 an actual saving of 5 per cent. is made of the coal burned.

There is a great diversity of opinion among practical men as to the percentage of CO_2 that should be carried to get the best results. Some find the higher the CO_2 the better, up to 14 or even 15 per cent.; others claim that when 10 per cent. is exceeded the loss due to CO in the flue gas becomes greater than the gain due to the reduction in excess air. Both statements are claimed to be based on actual experience and one must accept them as facts and search for the reason.

The writer has examined over 1200 gas analyses from various sources ranging from 5 to 16 per cent. of CO_2. These analyses are from three different plants. Classifying them according to CO_2 and their source, I find (1) 115 analyses with CO_2 running from 5 to 7 per cent.; of these 115 analyses, 23 contain CO varying from 0.1 to 0.5 per cent. (2) From the same source I have 48 analyses running from 10 to 11.4 per cent. in CO_2, of which all but 13 contain CO, varying from 0.1 to 2.1 per cent. This would seem to prove the contention of those who claim that when the CO_2 exceeds 10 per cent. there is danger of losing more in fuel (CO) than is saved in heat. (3) I also have several hundred analyses from another source, 49 of these running from 12 up to 13.8 per cent. of CO_2. Of these 49 analyses, only 10 show CO which varies from 0.1 to 0.4 per cent. This proves the contention of those who claim that there is no danger of appreciable loss due to the presence of CO with CO_2 up to 14 per cent. (4) Again I have over 200 analyses from a third source varying from 8 to 13.9 per cent. in CO_2.

The lowest 25 samples vary from 8 to 10 per cent. in CO_2, and all but 4 contain CO varying from 0.1 to 0.4 per cent. The 25 highest samples contain from 13 to 14 per cent. of CO_2; all these show CO from 0.1 to 0.8 per cent. All the foregoing analyses were made from average gas samples taken over periods of from 6 to 10 hours.

(5) Further, I have 124 analyses made from individual samples varying from 9.8 to 16.6 per cent. in CO_2. Of these 124 samples, 69 contained CO, of which constituent 0.3 per cent. occurred in the sample showing the lowest CO_2 — viz., 9.8 per cent—whereas the sample showing 16.6 per cent. of CO_2 contained no CO. The CO was distributed as follows with reference to CO_2: The one sample with CO_2 below 10 per cent. contained 0.3 per cent. of CO. Out of eight samples with CO_2 from 10 to 12 per cent., 2 contained CO. Out of 25 samples with CO_2 from 12 to 14 per cent., 5 contained CO. Out of 36 samples with CO_2 14 to 15 per cent., 24 contained CO. Out of 42 samples with CO_2 15 to 16 per cent., 29 contained CO. Fourteen samples contained 16 to 16.6 per cent. CO_2 and but seven of these showed CO with only one case in which CO exceeded 0.5 per cent.

It seems evident from the foregoing, first, that low CO_2 is no guarantee against loss through CO; second, that high CO_2 may be obtained without great danger of considerable fuel loss in the form of CO if the proper conditions are maintained. In this connection the fact should be borne in mind that the fuel loss due to CO decreases as the percentage of CO_2 increases; that is, 0.5 per cent. of CO occurring with 7 per cent. of CO_2 is equivalent to 1 per cent. of CO occurring with 14 per cent. of CO_2.

Appreciable amounts of CO should not occur with CO_2 up to 14 to 15 per cent. when burning anthracite coal, nor with CO_2 from 12 to 13 per cent. when burning bituminous coal. The higher the percentage of volatile matter, the lower the percentage of CO_2 that can safely be carried.

CO in conjunction with low CO_2 in the flue is due to two causes: The first and most prolific cause is air infiltration. Large quantities of air are drawn in through the pores of the brickwork, through cracks in the boiler walls, through warped and badly fitting cleaning doors, diluting the real products of combustion, in consequence of which the flue gas shows low percentage of CO_2 — that is, a great excess of air—while at the same time the air supply to the fire is insufficient for complete combustion. The second cause is an uneven fire bed, too much air passing through the thin or bare spots while the thick portions receive an insufficient supply. In every case where CO occurs in conjunction with low CO_2, either one or both of these causes are operative. Insufficient flame temperature due to lack of combustion space may be mentioned as a third cause of high CO in the flue gas. In a properly constructed furnace, with a hot fire and an even coal bed of the proper thickness, flue gas containing 14 to 15 per cent. of CO_2 with only traces of CO will be obtained when burning anthracite coal provided the boiler setting is quite tight. With low-volatile bituminous coal 13 to 14 per cent. of CO_2 should not be exceeded, and with high-volatile coal it will be more difficult to have 13 per cent. of CO_2 and no CO in the flue gas than 15 per cent. with anthracite coal.

That it is possible to have very high CO_2 with little or no CO appears evident from the fact that of the 14 analyses of flue gas referred to, running from 16 to 16.6 per cent. of CO_2, 7 show no CO and the average of this constituent in the other 7 is only 0.33 per cent. In contrast to this are the 48 analyses running from 10 to 11.4 per cent. of CO_2, of which only 13 are free from CO and the remaining 39 show an average of 0.48 per cent. of CO.

This apparent anomaly is readily explained by the fact that the very high CO_2 with low CO was obtained from anthracite coal burned in a tight boiler setting; whereas the comparatively low CO_2 and higher CO were obtained from an average boiler burning bituminous coal, with air infiltration, probably exceeding 25 per cent. above that passing through the grates. From this it is clear that if the boiler had been tight the flue gas would have shown CO_2 from 12.5 to 14.25 per cent., or an average of 13.4 per cent. and 0.6 per cent. CO. Even with this high average the CO should have been much lower, indicating uneven firing or flame contact with the cold surfaces of the boiler before combustion was completed.

Below are results of 281 tests compiled by Professor Breckenridge from the Government coal tests made at St. Louis during and after the Louisiana Exposition, grouped with relation to CO_2 and efficiency:

Group	Number of Tests	Average CO_2, Per Cent.	Average Efficiency, Per Cent.
1	3	5.5	55.5
2	24	7.6	62.0
3	75	9.5	65.0
4	43	11.4	66.0
5	9	6.5	56.0
6	62	8.6	64.2
7	57	10.4	65.0
8	8	12.4	65.5

That the efficiency in groups 4, 7 and 8 is considerably lower than it should have been is undoubtedly due to bad furnace conditions as well as bad firing, as is indicated by the high CO cited in my second group of analyses which were obtained from the same source. Loss of coal through the grate bars and stack temperature are two other factors that modify the relation between CO_2 and over-all efficiency.

In POWER of May 9, Frank T. Clark publishes a very full report on seven boiler tests using crude oil as fuel. I have here arranged these tests showing the relation of CO_2 to boiler efficiency.

RELATION OF CO_2 TO BOILER EFFICIENCY

No. of Test	Average CO_2, Per Cent.	Boiler Efficiency, Per Cent.	Temperature of Escaping Gas, Degrees	Rate of Driving, Per Cent.
1	12.2	81.1	385.3	72.7
2	13.3	82.4	409.1	109.4
3	13.4	82.8	397.5	94.0
4	14.3	83.3	406.2	109.2
5	14.2	81.5	429.0	132.8
6	13.3	76.4	477.1	163.0
7	12.1	75.8	537.5	195.5

These tests show conclusively that there is a true relation between CO_2 and efficiency. The apparent discrepancy between Nos. 1 and 7 is readily accounted for by noting the difference in the rate of driving which resulted in a much higher stack temperature and no doubt also in a loss of fuel through incomplete combustion. This also accounts for the discrepancy between tests 2 and 3 as compared with 6 and to a lesser degree also between tests 4 and 5. But under similar conditions, and within proper limits, increased CO_2 means increased boiler efficiency.

With the above statements of facts I hope to have demonstrated, in a measure at least, that high CO_2 means high efficiency and low CO_2 means low efficiency.

That CO_2 cannot be a measure of boiler efficiency must become evident from the fact that CO_2 is a loss factor and in no way enters into the calculation of boiler efficiency. It is, however, an idex to efficient firing, and if brought in continuous evidence it serves as a guide to the fireman by the aid of which he is enabled to attain and maintain maximum combustion efficiency. CO_2 and stack temperature are the two factors required to keep tabs on the waste up the chimney, and since these constitute 80 to 90 per cent. of all the controllable heat losses, their importance should attract more attention.

Draft is an important factor in relation to capacity as it controls the rate of combustion, but it has no bearing on CO_2 and fuel economy except as the latter is affected by the rate of driving.

Illinois has produced more coal than any other State except Pennsylvania, the total tonnage since 1833, when coal mining first began in the State, being 790,333,235 short tons, according to the United States Geological Survey. Last year the production was 45,900,246 tons and the State stood third, Pennsylvania producing 235,006,762 and West Virginia 61,671,019 tons.

Bristol's Ink Type Recorder

The Bristol Company, of Waterbury, Conn., has recently developed and placed on the market a frictionless ink-type recording instrument which will accurately record millivolts and is adaptable for use as a recording electric pyrometer. In external appearance it resembles the Bristol patented semi-transparent smoked-chart recorder which has been previously described in POWER.

The new instrument, which was patented by William H. Bristol on April 13, 1909, was designed to fill the demand for a recorder in which the record is made with ink. According to the manufacturer, it has been thoroughly tested out in practical service for two years past and is the result of several years of study and experience with an original patented design of the frictionless ink recorder using a hinged electrical movement carrying a retaining receptacle for marking fluid which extends over the path of the recording tip and is provided with means for periodically making contact with the source of marking fluid and the chart.

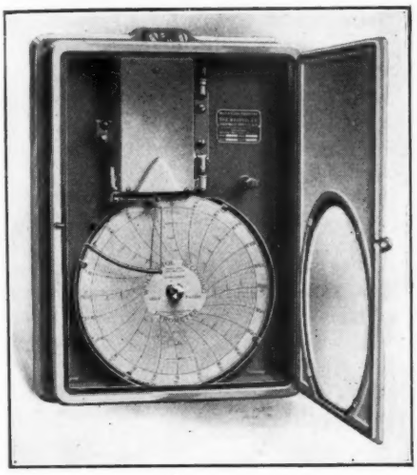


FIG. 1. BRISTOL INK TYPE RECORDER

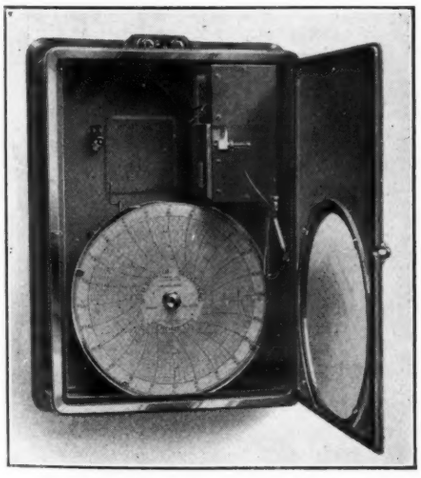


FIG. 2. ELECTRICAL MOVEMENT SWUNG TO ONE SIDE TO REMOVE CHART

Fig. 1 is an interior view showing the galvanometer movement case hinged to the back of the instrument and carrying the inking pad in front of the recording arm. Fig. 2 shows the sensitive electrical movement swung to one side for convenience in removing the record and inserting a fresh chart. A capillary gold tube open at both ends is carried at the end of the recording arm at right angles to the surface of the chart. The inking pad is suspended from the case of the electrical movment and is curved to correspond with the arc covered by the motion of the end of the recording arm.

When the movement is swung back into its operating position, Fig. 1, the recording arm can swing free, accommodating itself to the position corresponding to the delicate current which is to be measured. The clock which revolves the chart at the desired speed also automatically presses the inking pad toward the chart every 10 seconds, bringing one end of the capillary tube into contact with the chart, and the opposite end simultaneously into contact with the inking pad. A fine dot of ink is left on the chart and the capillary tube is replenished with ink from the pad. The recording arm thus carries a constant supply of ink, and its perfect balance, which is very important, is always maintained. The electrical movements used in these recorders are made especially for the purpose by the Weston Electrical Instrument Company.

Although the most important applications of these recording instruments have been for pyrometers, they have also been used for electrolytic research, recording voltmeters and recording shunt ammeters.

Indicator Reducing Motion

A new reducing motion recently brought out by the C. & G. Cooper Company, Mount Vernon, O., is illustrated herewith. It is a combination crosshead-pin oiler of the pendulum type with an indicator-motion attachment which has the special features of being an accurate reduction of the piston's movements with variable card-length control and a swivel pulley over which the wire cord connects direct to the indicator drum, eliminating all error.

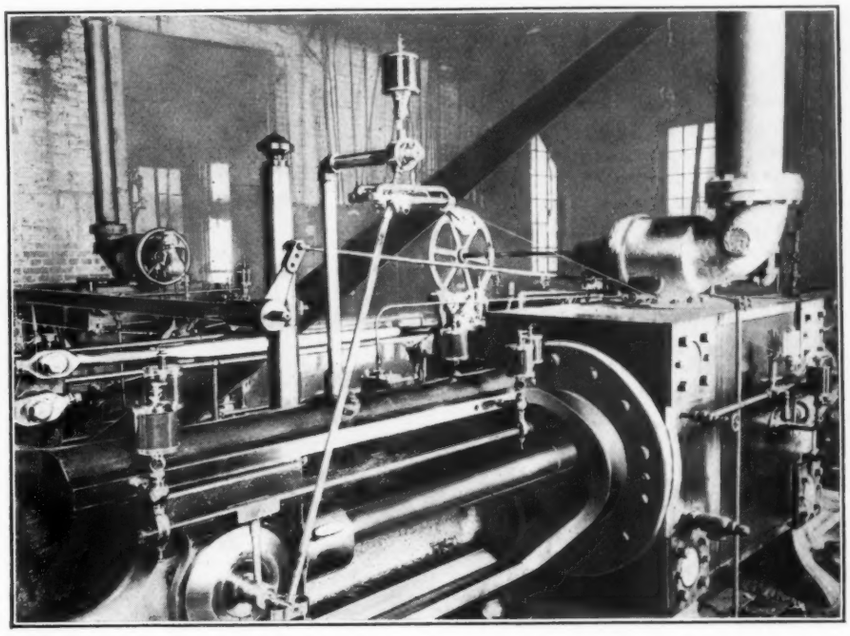


FIG. 1. REDUCING RIG ATTACHED TO ENGINE

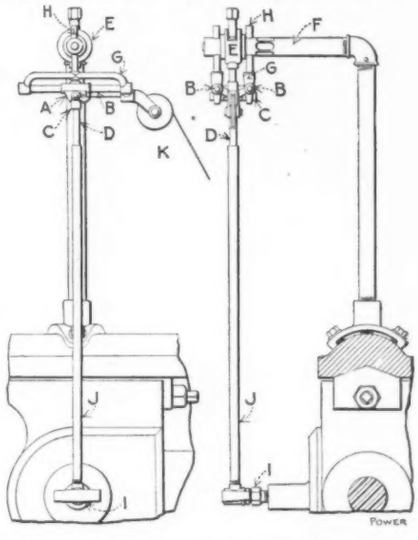


FIG. 2. DETAIL OF REDUCING MOTION

This device is built on straight lines; the motion for driving the indicator becomes an accurate reproduction of that of the crosshead to which the telescoping oiler pipe or pendulum is attached. The device is shown attached to an engine in Fig. 1.

Referring to Fig. 2, *A* is a small crosshead, which is made to slide on two parallel bars *B* by a yoke *C* which is held to *A* by spring clamps for detachment when not in use. The yoke *C* slides on the pipe *D* to compensate for the usual arc motion. The pipe *D* is held rigid in the collar *E* and swings pendulum fashion on the stationary bar *F*. The hanger frame *G* supports the parallel bars *B* and is suspended by the pins *H* which pass through the bar *F* and is held at any chosen hight by a setscrew. The hollow swivel post *I* is screwed into the engine-crosshead pin to admit oil passing from the cup above through the pipes *D* and *J* which telescope over one another to correct for the arc of the pendulum they form over the straight line of the crosshead.

A wire cord *K* is attached to a revolvable pin in the small crosshead *A* and passes over the swivel pulley which is adjustable for angle and held in place by a bracket to the hanger frame *G*. The other end of the wire cord *K* is fastened to the indicator drum to which it imparts an exact proportional motion of the engine's piston.

The device can be attached to any type of reciprocating engine with very little change in the lengths of pipes *D* and *J* and the standard supporting the stationary bar *F* which must be rigid and free from vibration. It also permits getting an indicator card of any length from 3 to 4½ inches without sacrificing its accuracy through the adjustments necessary, which can be made without stopping. The limits of the card obtainable are shown in Fig. 3.

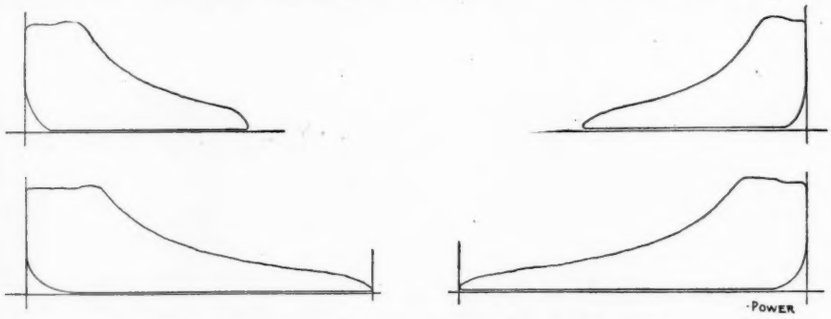


FIG. 3. RELATIVE SIZE OF DIAGRAMS OBTAINABLE

Improved Rotrex Pump

The Rotrex pump, which is manufactured by the C. H. Wheeler Manufacturing Company, Lehigh avenue and Eighteenth street, Philadelphia, Penn., has recently been improved, the principal difference from the earlier design being that the shape of the vibrating cam placed between the suction and the discharge chambers has been changed.

In the new design the center of gravity of the cam is located below the center of the shaft on which it swings, thus taking advantage of the action of gravity and producing a pendulum-like effect as against the former cam, where the action of gravity had to be overcome in the movement of the cam, due to the center of gravity being above the shaft.

The new cam is almost exactly balanced as regards discharge pressure; that is, at the end of the revolution and the moment of discharge, the pressure on the cam, caused by the atmospheric discharge pressure plus the vacuum underneath the cam, is directly on the shaft and through the bearings, as the projected area of the cam is equally located on both sides of the shaft center. There is no tendency to thrust the cam and rotor apart and the construction equalizes and reduces the load on the connecting rod driving the cam. The new cam permits a smaller, lighter yet more rigid construction of the pump, and due to its better balance, enables the pump to run at a high rotative speed. The details are shown in Fig. 1.

In Fig. 2 is shown a Wheeler surface-condensing equipment consisting of a condenser, with a centrifugal circulating pump and an improved Rotrex vacuum pump, both mounted on the same shaft and driven by the same engine. There is also a centrifugal hotwell pump which is used to lift the condensed steam discharged by the air pump into an elevated hotwell or feed-water heater. This hotwell pump is a recent addition to the equipment and is driven by a noiseless chain belt.

Static Boiler Feed Regulator

The Static boiler-feed regulator consists essentially of a diaphragm which actuates the valve stem and disk of the

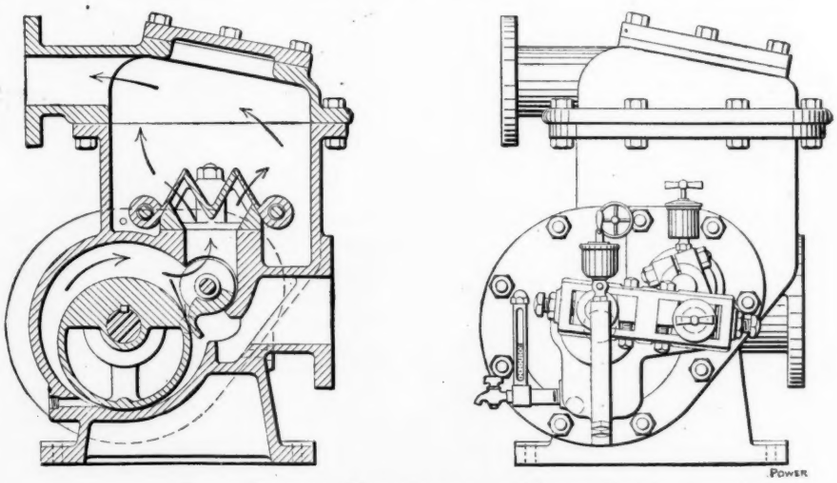


FIG. 1. SHOWING IMPROVEMENT IN ROTREX PUMP

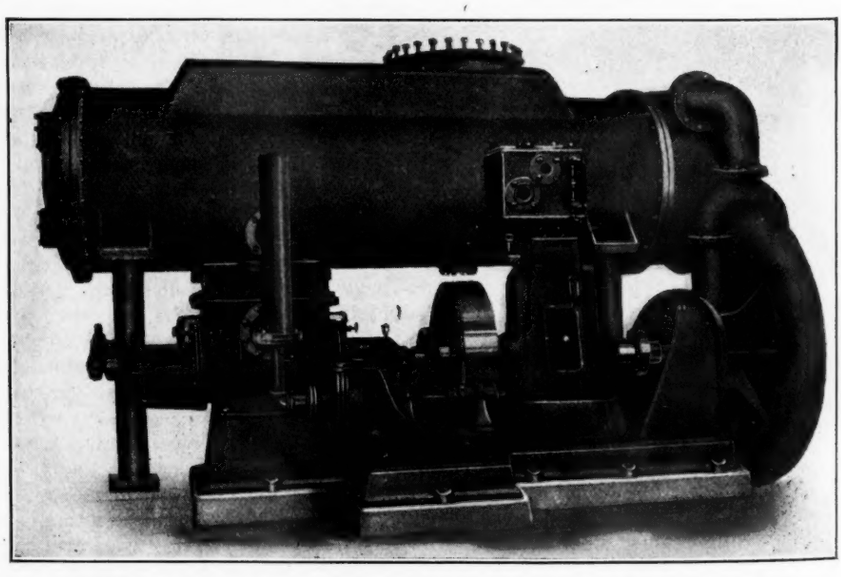


FIG. 2. NEW CENTRIFUGAL HOTWELL PUMP ATTACHED TO CONDENSER OUTFIT

feed valve. These three parts are bolted together as one. The controlling device is composed of a small standpipe which terminates at the set-water line within the waterlevel chamber. The static pipe is placed within a condenser pipe and has at its upper end an open cup or reservoir. This is shown in Fig. 1. The

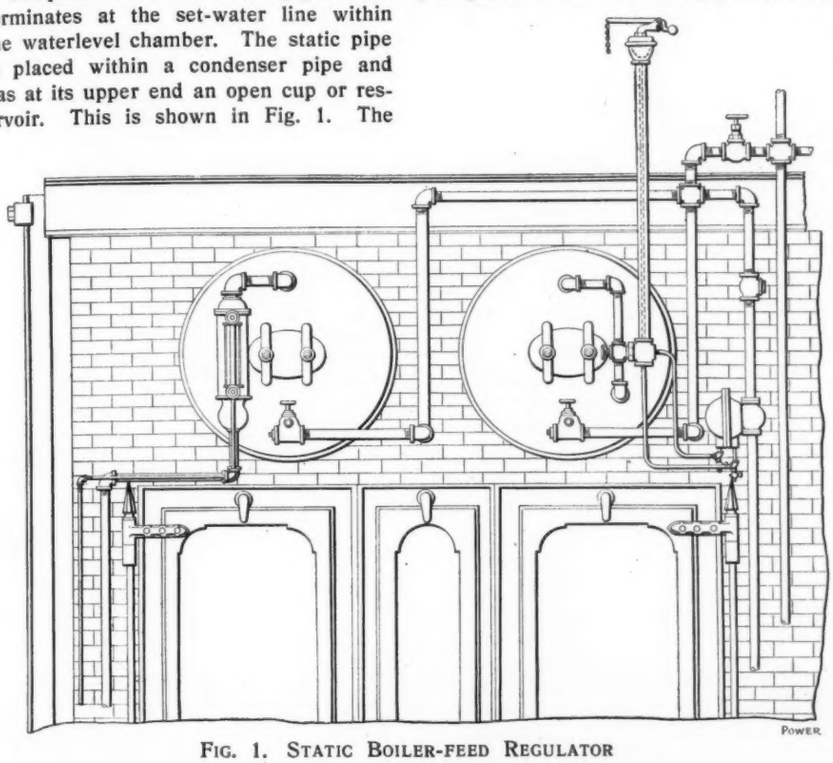


FIG. 1. STATIC BOILER-FEED REGULATOR

static pipe passes down through the condensing standpipe and connects to the side of the diaphragm which is next to the body of the feed valve. The opposite side of the diaphragm is connected directly to the boiler.

The diaphragm is initially loaded by springs and both diaphragm and springs are constructed of a noncorrosive metal.

The valve stem connecting the diaphragm and valve disk passes through a loosely packed gland which prevents leakage. The feed valve is placed with the pump-line pressure side next to the diaphragm. The contents of the static pipe will not escape into the valve body, but any small leakage by the valve stem will overflow at the top of the static pipe and does not disturb the operation of the regulator.

The reservoir at the top of the static pipe is of a greater cubic area than the displacement of the diaphragm stroke. The diaphragm is designed to withstand 350 pounds pressure per square inch on either side while open to the atmosphere on the other.

The operation of the regulator depends on the filling of the annular space between the inner and outer pipes of the standpipe with water when the water in the boiler is higher than the bottom of the condenser pipe, and on the emptying of this space when the water falls below the bottom of the condenser pipe. When the water is low in the boiler the condenser pipe is empty, as it is impossible to keep water in the condenser pipe after the end is uncovered, and full boiler pressure is admitted to the top of the standpipe. That side of the diaphragm to which the static pipe connects will then be under boiler pressure plus the head of water in the static pipe.

The chamber on the other side of the diaphragm will always be under boiler pressure. A difference of 2½ pounds per square inch on 50 square inches effective diaphragm area gives a lifting force of 125 pounds with which to lift both the balanced valve and loading springs. When the bottom of the condenser pipe becomes submerged as the hight of the water in the boiler is raised, the steam supply to the condenser pipe is sealed. As the steam condenses the water then rises into and fills the condenser tube and the weight of this water neutralizes the constant head of the static pipe within. Under the flooded condition of the condenser pipe hydrostatic equilibrium is set up in the diaphragm and the loading spring closes the valve.

When the water falls below the set water line, steam is admitted to the bottom of the condenser tube and the column breaks and falls, which action restores the lifting power of the diaphragm.

The regulator is protected from floating foreign particles by a steam connection above and a water connection below the water line.

The regulator is manufactured by the Static Engineering Company, Arlington, N. J.

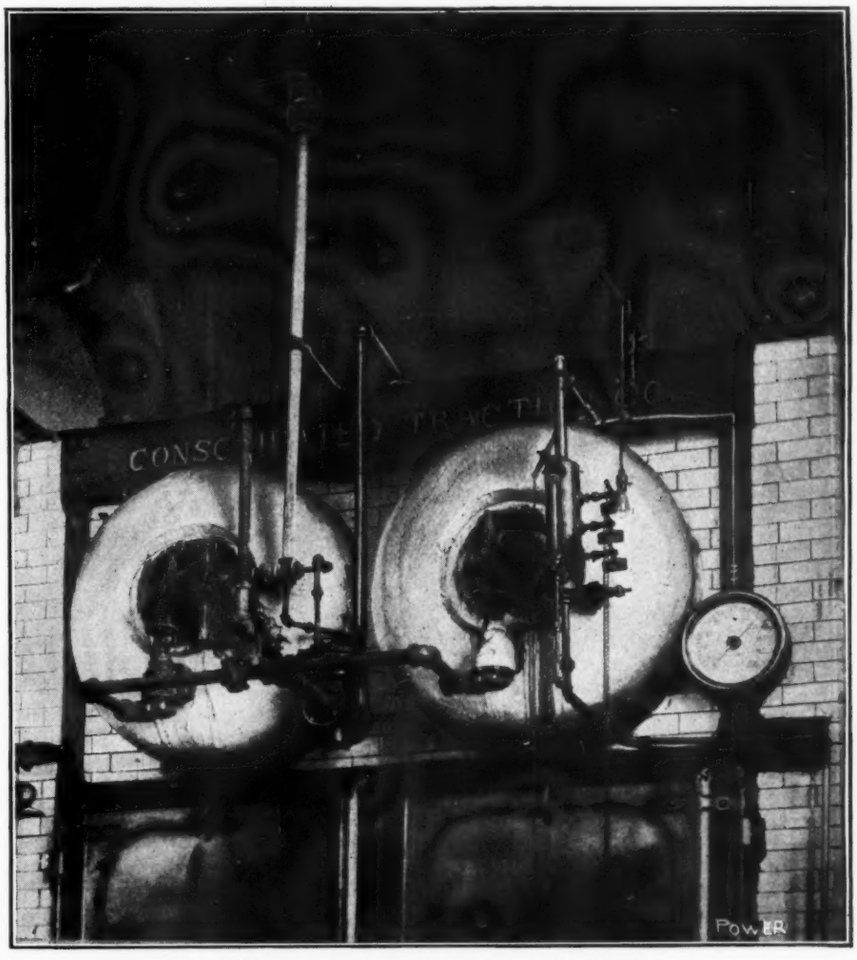


FIG. 2. STATIC REGULATOR IN SERVICE

Electrical Department

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Changing Alternating to Direct Current

By C. A. Tupper

There has been conspicuously observable of late an almost universal tendency to adopt alternating-current generating apparatus and to extend the development of alternating-current transmission. This is found desirable not only for long distances but frequently for shorter ones also. The use of direct-current motors has, however, proved so necessary for certain applications that a large percentage of the power generated is applied through apparatus of this class. To make possible the use of the two systems in connection with each other, two general types of machines have been developed. These are known as the rotary converter and the motor-generator. Each of them is best suited for some particular kind of work and the choice will depend upon the engineering and economic considerations entering into the problem.

From the fact, however, that there are at present rotary-converter installations of an aggregate capacity in the neighborhood of 1,200,000 kilowatts, which is more than that of any other type of current changer, it would seem that the rotary converter meets a greater variety of requirements than does the motor-generator. The writer found, during a recent trip abroad, that the advantages of the former are more generally recognized in England and on the continent than in this country, with greater development of the practical features attending its use. Fig. 1 shows one of the latest types of rotary converter designed and built by Vickers, Ltd., of Sheffield, England.

The field of application and usefulness of the rotary converter is, however, being enlarged constantly in all parts of the world. Its first use was probably in connection with long transmission lines and on interurban electric roads. Probably the greater number of installations now being made is in connection with railway work.

At present, transmission in cities over distances greater than two miles is usually effected by means of alternating current and rotary-converter substations are used to change over to direct current. In large cities, especially, the load is very heavy, and to distribute direct current for any distance would require extremely large cables or a large number of cables. The placing of substations comparatively close together, connecting them with the central station by high-tension lines, and then using short lines for feeders, helps to keep down the line losses.

In various commercial lines outside of central stations the rotary converter is being considerably used. With the introduction of electricity into mining operations there has been a demand for a great variety of electrical apparatus. Instead of having isolated steam-engine installations modern practice tends toward a central electrical plant serving the several shafts and mills. The electric mule has displaced the four-legged one in mine haulage, and as a safeguard to life direct current at low voltage has been generally adopted for use. As this cannot economically be transmitted a great distance, a demand has developed for alternating-current transmission to 250-volt rotary converters. Many mines are now equipped with installations of this character; Fig. 2 illustrates a typical one.

Rotary converters have found considerable favor in manufacturing plants which cover a large ground area, where machine tools are driven by direct-current motors. Instead of generating and transmitting direct current, alternating current is used and changed to direct current in each shop by the use of a rotary converter. This method reduces the multiplicity of large wires necessary with direct current to transmit the large power requirements. One such installation is shown in Fig. 3.

One method which has been used to show, roughly, the condition obtaining in a rotary converter is to consider it as being developed in several successive steps. Taking the motor-generator set, consisting of a synchronous motor and a direct-current generator, assume that the two armatures are brought side by side on the same shaft within a single field magnet. Then consider the further simplification which results from placing the two armature windings on the same core; finally think of the effect of interconnecting the two armature windings or using a single winding for both sets of brushes, and an idea is obtained of what happens in the armature winding of a rotary converter.

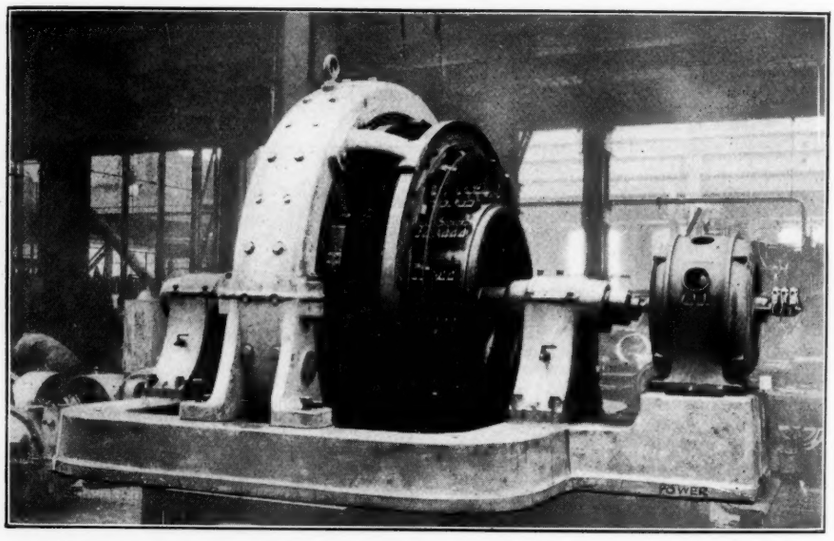


Fig. 1. Rotary Converter of 500 Kilowatts Capacity and Starting Motor

Although the rotary converter has been aptly described as a direct-current machine to which slip rings, connected to suitable points on the armature, have been added, it is essentially a single machine combining the features and characteristics of a synchronous motor and a direct-current generator. As the current in the armature coils of a direct-

current machine is actually alternating before being changed at the commutator brushes, the rotary converter can also be considered as a direct-current machine receiving from an outside source a current which has the same frequency and pressure as that which the machine would generate within its armature winding if driven at the rated speed.

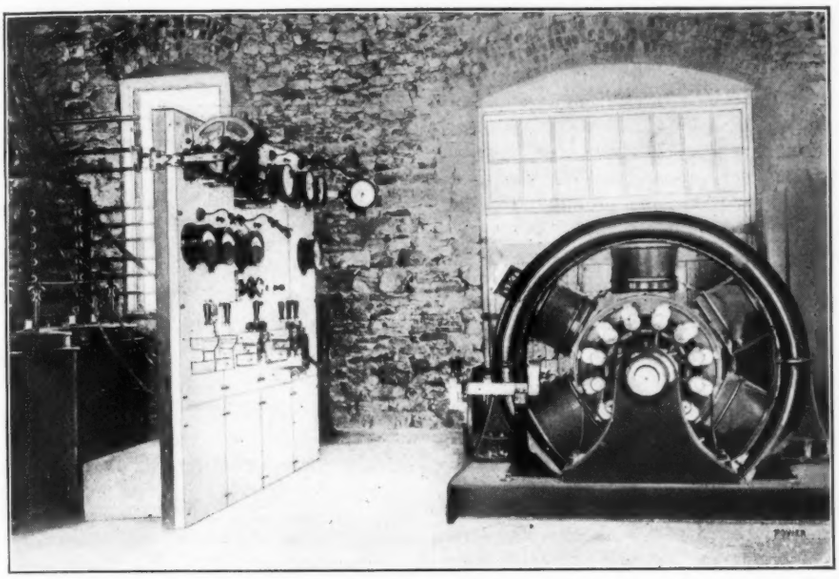


FIG. 2. ROTARY CONVERTER AT SUBSTATION OF MCKELL COAL AND COKE COMPANY

Having determined the voltage normally desired on the direct-current side of the machine, the line voltage is "stepped down" in transformers so that the voltage at the brushes on the alternating-current side has the proper ratio, which is fixed, to the voltage of the direct-current side. On a three-phase machine, which is the most common, the alternating-current voltage is about 63 per cent. of the direct-current voltage. As an example of the relations existing between the alternating and direct-current side, consider a three-phase 50-cycle machine, with eight field-magnet poles, delivering direct current at 575 volts. This will receive alternating current at about 360 volts and will run at 750 revolutions per minute. If the machine be driven as a direct-current motor, at the same speed, 50-cycle alternating current can be delivered at the collector rings at a voltage somewhat below 360, say about 350. Operating in this manner the machine would be called an "inverted" rotary converter.

There are three ways in which rotary converters may be started, and as the alternating-current side of the machine is the same as a synchronous motor it must in all cases be brought into synchronism with the supply current before being connected to the circuit. The machine can be started from the direct-current side as a motor if it is connected to a general direct-current system supplied by some other source; it can be started by means of a small induction motor (usually connected directly to the shaft, as shown in Fig. 1), or it can be started from the alternating-current side as a motor by supplying a reduced voltage to the slip rings, as in the case of some induction motors. This reduced voltage is usually obtained from taps on the transformers. When the machine is started in the manner last mentioned the field circuit must be opened. This method has the advantage that the machine automatically falls into synchronism.

In the other type of apparatus used for changing alternating into direct current, the motor-generator, the rotating parts of both the motor and the generator are usually mounted on the same shaft. The motor in such a set may be of either the induction or synchronous type, depending on requirements. In some cases the unit is started from the direct-current side, but ordinarily it is started from the alternating-current side by means of an autotransformer, which reduces the applied voltage at starting and thereby prevents too great a rush of current, or from taps on the secondaries of the main transformers, if transformers are used between the motor and the supply circuit.

As both the rotary converter and the motor-generator accomplish the same result, that of changing alternating to direct current, the choice of machines depends largely on the nature of the load on the direct-current side. Generally, however, the rotary converter has certain advantages which recommend it for use. It has only one armature and consequently offers less mechanical difficulty than the motor-generator; it is also cheaper in first cost than the motor-generator and usually more efficient, so that the running charges are less. Considering the machine alone, the converter occupies less space than the motor-generator; this is offset, however, when the motor-generator can be operated at the line voltage without transformers.

One advantage of the rotary converter, when used where the power load is a rapidly fluctuating one, is that there is no armature reaction and the "pull" on the machine, therefore, can be varied enormously. Instances are recorded of temporary overloads equal to 300 per cent., and the carrying of 100 per cent. overload for some time. Where the load is of the lighting class rather than power, the duration and heating effect of the overload must necessarily be taken into consideration.

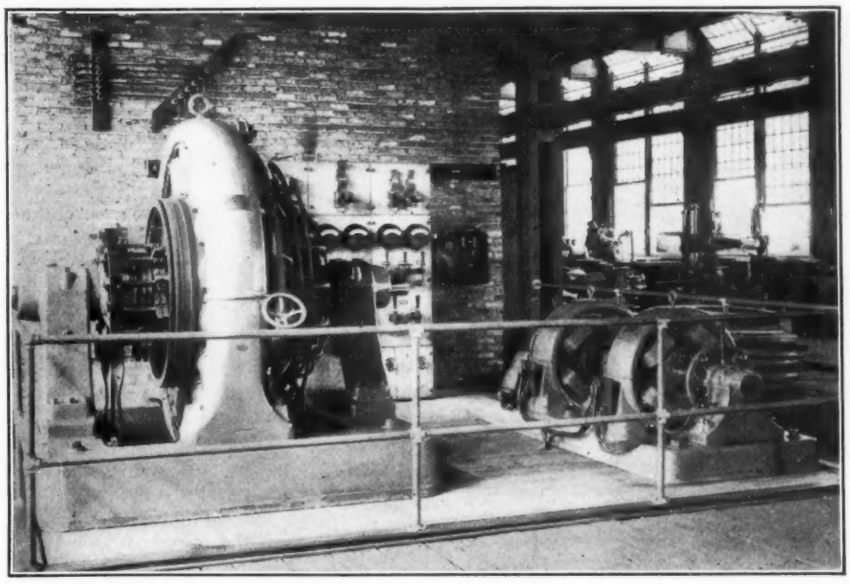


FIG. 3. ROTARY CONVERTER OF 300 KILOWATTS IN WEST ALLIS WORKS OF ALLIS CHALMERS COMPANY

One objection formerly offered to the rotary converter was the fact that the direct-current voltage was directly affected by fluctuations in the alternating-current voltage, but in modern installations of generating machinery there is little fluctuation of voltage.

The question of the best type of machine to be employed in consideration of the frequency of the alternating-current system has often been discussed. With 25 cycles and other low frequencies, the converter is usually employed. With 60 cycles and other high frequencies the operation of converters is attended with some difficulty, especially when the direct-current voltage is above 500. Flashing over and hunting have been the chief troubles. In this country there have been installed some 60-cycle rotary converters for railway service but they are rapidly being displaced, especially in sizes above 500 kilowatts. Some builders do not recommend making high-frequency rotary converters at all, and refuse to build any of this frequency for 500 volts or above. The accompanying table specifies what is considered best in general practice; although there are, of course, exceptional cases where a deviation from this is desirable.

Direct Current Voltage	Alternating-current Frequency	
	25 Cycles	60 Cycles
125	Motor-generator	Rotary converter
250	Rotary converter	Rotary converter
600	Rotary converter	Motor-generator

The rotary converter has already proved so serviceable in so many different ways that there is no question of its continued and increasing use, but there is among consumers of power generally an amazing lack of knowledge concerning its advantages.

Precautions against Electric Shocks

The United States Bureau of Mines has just issued a pamphlet designated "Miners' Circular 5" which is devoted to electrical accidents in mines and contains some useful information as to the conditions which favor accidents, common causes of them and means for preventing them. The following precautionary suggestions are taken from this pamphlet.

The best way to avoid electric shocks is to show due respect for the electric current. Indifference to the dangers of electricity does not indicate courage or wisdom, but poor judgment and ignorance. The fact that a man does not get hurt when he is careless in handling electric wires does not prove that he is cleverer than other men, but rather that he is more fortunate. The worst feature of such acts is the bad effect that they have on those who see them or are told about them. Those who know about electrical apparatus and are employed to handle and repair it should try to teach others to be careful instead of encouraging them to be careless.

The only sure ways to escape shocks are to keep away from the trolley wire, especially when carrying tools; to avoid touching electrical machines unnecessarily; and to provide and use some means of insulating the body when making repairs on electrical apparatus. If there is a way to cut off the current from apparatus the current should be cut off before the apparatus is handled. If it is necessary to work on apparatus that is carrying current, every precaution should be taken to insulate the body from the ground.

It is impossible to tell whether conditions are safe unless the workman has made them so himself. No one can tell by merely looking at a motor whether or not the parts that carry current have come in contact with the frame of the machine. A workman cannot be certain whether the place where he must stand to repair live apparatus will sufficiently insulate his body from shock. The only way for him to be safe is to provide something suitable to stand on while making repairs. In doing this he should remember that *dryness* is the most desirable quality. Dry boards, free from nails, are good for the purpose.

Rubber gloves or leather gloves in good condition and without metallic fastenings will protect the body from shock. If the rubber covering of gloves is worn thin the gloves give almost no protection. The same is true of leather gloves that are damp with water or sweat. Rubber boots without nails in the soles or heels are good protection when new, but if the soles are worn or cracked, their insulating value is doubtful.

The position of the body is an important matter in handling apparatus that is carrying current. If a man has merely to make some adjustment he should use but one hand, if possible. He should also try to place his body so that the involuntary recoil from a possible shock will remove his hands from the apparatus instead of causing them to grasp it.

The use of rubber tape on the handles of pliers, screwdrivers, and wrenches cannot be depended on unless the tape has been freshly and carefully applied. Rubber coverings for the handles of such tools are a protection if the coverings are new and in good condition, but even then the chances are great of touching the hand or the fingers to an uncovered part. Insulated tools should not be trusted to give entire protection.

There is one practice that cannot be condemned too severely, and that is the wilful giving of electrical shocks to others. This may be done impulsively or may be deliberately planned, but it is always dangerous.

CORRESPONDENCE

Mr. Fox's Alternator Trouble

In the October 31 issue, Charles Fox, of Bay Ridge, O., describes trouble he has had with two alternators. I would suggest that the two machines are probably not exactly in synchronism as regards the piston positions of the engines. There is always more or less unevenness in the rotative effort of any engine, regardless of the size of the flywheel, and it may be that these two machines are not so synchronized that the rotative efforts of the two engines are distributed alike throughout each revolution. I think it would be well worth while for Mr. Fox to try to get the two machines into step as regards the crank effort, and see if his troubles do not disappear.

HENRY D. JACKSON.

Boston, Mass.

My opinion of the trouble in paralleling alternators, described in the October 31 issue by Charles Fox, is that difference in engine regulation causes the trouble. Unless the regulation is exactly the same on the two engines, there will be only one load at which the alternators will divide the load smoothly without cross currents. At any greater load, the engine which regulates more closely will be trying to run faster than its mate; at any lesser load, the close-regulating engine will try to lag behind its mate. In both cases there will be surges of cross currents.

We had the same trouble Mr. Fox describes with two two-phase machines until we discovered that the two engines had different speed drops from no load to full load. When this was corrected the trouble disappeared.

DAVID SMITH.

Wellesley, Mass.

Treatment of Commutator Brushes

Replying to the recent letter from Manilal K. Desai, advising the use of kerosene for lubricating carbon brushes, I find that brushes soaked in kerosene will be softer and that the carbon will rub off on the commutator, covering it with smut and causing poor contact with the brushes.

I have had very good results on a 125-volt, 112-ampere direct-current generator by soaking the brushes in machine oil for 24 hours, then wiping them clean and allowing them to dry for six or seven days. I find that it hardens them and does not allow the carbon dust to rub off, which makes them wear longer and make better contact on the commutator; moreover, the sparking has entirely ceased.

HERBERT HILL.

Middle Falls, N. Y.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Improved Rathbun Valve Gear

The accompanying engravings illustrate the improved valve gear now used on the gas engines built by the Rathbun-Jones Engineering Company, of Toledo, O. The main features of the engine other than the valve gear are well known and have not been materially changed. The valves are actuated by individual eccentrics instead of by the cam and roller arrangement previously used and the rocker arms have exactly the same features of operation which characterize the well known wiper cam levers used

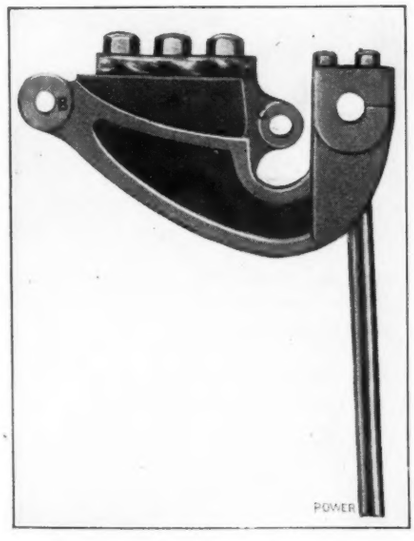


FIG. 1. ROCKER AND ANVIL

on many large gas engines, but are of simpler construction. There is only one rocker arm for each valve and that fulcrums on the face of a curved anvil *A*, Fig. 1, which is stationary. When the push rod starts upward, the rocker arm fulcrums against the extreme left-hand end of the anvil, giving the push rod large leverage over the valve. Continued motion of the push rod, however, produces a sort of rolling motion at the face of the rocker arm which transfers the fulcrum rapidly to the right-hand end of the bearing surface of the anvil, thereby reducing the leverage and accelerating the motion of the valve, which, of course, is a desirable feature.

The end *B* of the rocker arm is connected by a pair of links with the pivot pin *C*, which is mounted in an extension of the anvil block; the links straddle the anvil block. The function of the links is merely to keep the various parts in line. The rolling motion of the rocker arm along the face of the anvil is obtained by making the curve of the anvil face of a different radius from that of the curve of the rocker face, the radius of the latter curve being the longer of the two.

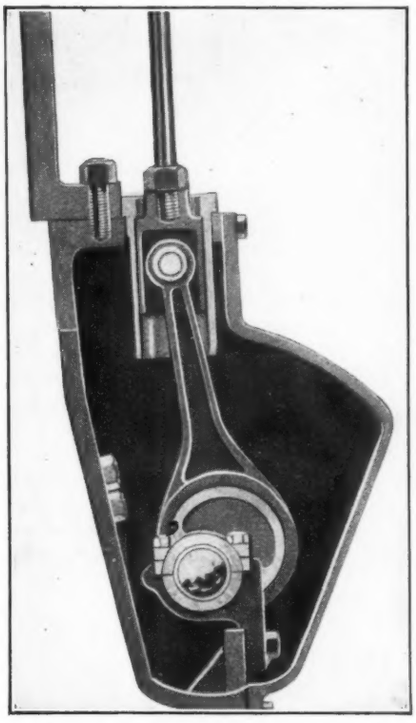


FIG. 2. ECCENTRIC AND PUSH-ROD CONNECTION

Fig. 2 illustrates the connections between the valve-gear shaft and the push rod. An ordinary eccentric is mounted on the valve-gear shaft and the arm of the eccentric strap is pivoted to a tubular crosshead which slides in a cylindrical guide. The push rod is attached to the upper end of the crosshead block.

Fig. 3 shows the complete valve gear in position on the engine.

Cost of Power Produced by an Oil Engine*

BY F. P. PFLEGHAR AND E. H. LOCKWOOD

A horizontal De La Vergne oil engine of 125 horsepower rating was installed by the Pfleghar Hardware Specialty Company in 1907 to drive a 220-volt direct-current generator supplying current to motors in the shops. The engine cylinder is 27 inches in diameter and the stroke 33 inches. The fuel is petroleum fuel oil, costing 3¼ cents per gallon, delivered. For two years the oil engine gave considerable trouble, due primarily to the manner of connecting the exhaust

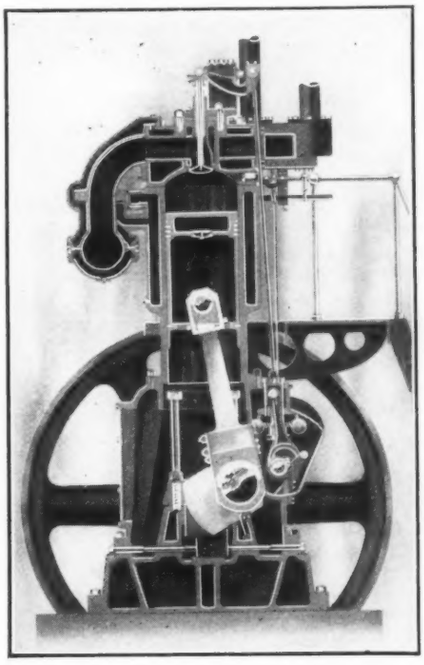


FIG. 3. COMPLETE VALVE GEAR

pipe and to the cooling-water connections to the piston. During the summer of 1910 extensive repairs were made, resulting in greatly improved performance, and it is now considered as reliable as a steam engine. A few months after installation the engine was carefully tested for output and fuel consumption, and found to be very economical of fuel.

The daily cost of operation of the engine is approximately as follows, the running time being 10 hours, and the average output 90 horsepower:

*Paper read at a meeting of the American Society of Mechanical Engineers, held November 15, at New Haven, Conn.

Fuel	$7.18
Labor (one man, half time)	1.50
Oil, waste, cooling water, repairs	1.00
	$9.68
Cost of operation per year of 300 days	$2904.00
Cost of operation, per year per horsepower	32.30
Cost per horsepower-hour	1.08c.
FIXED CHARGES	
Cost of engine, $6000; 10 per cent. of cost	$600.00
Cost of heating boiler, $1000; 10 per cent. of cost of heating boiler	100.00
Insurance and taxes	250.00
	$950.00
Cost of fixed charges per year per horsepower	$10.55
Total cost per year per horsepower	42.85

COMPARISON WITH STEAM POWER

Owing to the troubles experienced in the beginning, a 100-horsepower steam engine and boiler were installed. The operating costs per day for the steam plant, delivering 90 horsepower, were as follows:

Fuel	$11.90
Labor (one man, full time)	3.00
Oil and waste	1.00
	$15.90
Cost of operation per year of 300 days	$4770.00
Cost of operation per year per horsepower	53.00
Cost per horsepower-hour	17⅞c.
FIXED CHARGES	
On cost of engine and generator	$350.00
On cost of boiler	200.00
Repairs, insurance and taxes	250.00
	$800.00
Fixed charges per year per horsepower	$8.90
Total cost per year per horsepower	61.90

SUMMARY PER YEAR

	Oil Engine	Steam Plant
Operating cost per year per horsepower	$32.30	$53.00
Fixed charges per year per horsepower	10.55	8.90
Totals	$42.85	$61.90

LETTERS

Mr. Caton's Diesel Engine Diagram

A feature of the Diesel-engine diagram submitted by William R. Caton in POWER for October 31 (Fig. 1 herewith) will doubtless puzzle some readers who use indicators on which such a thing could not happen. I refer to the double atmospheric line with the cross lines between them. In some makes of indicators the piston is attached to the spring by a sort of ball-and-socket joint, a ball at the lower end of the spring being held between two cup-shaped screws. In a gas-engine indicator, the piston of which has considerable stem, the lower one of these screws has to be adjusted with a screwdriver from the lower end of the piston, but because of its inconspicuous position it is likely to be overlooked when the indicator is adjusted. Failure to tighten it makes possible a motion of the piston (and tracing point) which is not controlled by the spring, but only by the weight of the parts.

When the pressure in the cylinder is greater than atmospheric, the lower screw is pressed up against the ball on the spring and the upper portion of the diagram may be made very accurately. When, however, the pressure falls to atmosphere, as it did in Mr. Caton's diagram at about a quarter of the exhaust stroke, the piston drops until the upper screw rests on the ball, as shown in Fig. 2, which position it maintains until pushed up by the increase of pressure during the compression stroke.

Fig. 3, taken from a 9¼x16-inch gasolene engine running at 225 revolutions per minute, shows a case where the exhaust pressure is above the atmosphere during the whole exhaust stroke, the piston dropping at the beginning of the suction stroke.

G. W. MUNRO.

LaFayette, Ind.

The only explanation of Mr. Caton's Diesel-engine diagram, it seems to me, is that the pressure scale is not drawn in the right place. As every Diesel-engine piston draws in atmospheric air, the diagram should start at the atmospheric line; the zero should therefore be placed at *A* [Fig. 4]. Suction continues to the point *B* where the compression is supposed to start, and the line of the diagram during this period is a normal one for a full-pressure diagram. From the point *B* to the point *C* there does not seem to be any compression worth speaking of, but beyond this point the line rises sharply; this can be caused by a retarded closing of the inlet valve.

From *C* to *D* the compression curve is practically normal, but beyond *D* something is wrong with the diagram; it does not show the usual short horizontal line caused by the gradual injection and combustion of fuel. The sudden drop in pressure seems to indicate that the cylinder from which the diagram was taken was doing very little work, only enough oil having been fed to round the peak of the diagram.

The shape of the toe is also abnormal. This may be due to a badly worn exhaust-valve cam which opened the valve so slowly that the pressure remained practically constant from *E* to *F*. At the point *F*, the valve seems to have been opened full, allowing the gases to escape in the regular way, at about atmospheric pressure.

H. VANDERFEER.

Hoboken, N. J.

The Diesel-engine diagram submitted by Mr. Caton in the issue of October 31 is misleading because it has two atmospheric lines. This indicates that the indicator has lost motion, either from the spring not having been tight at the time the diagram was taken or because the joints of the pencil movement are worn. The effect of this is to diminish the hight of the diagram during expansion and to raise the whole bottom of the diagram during the compression by the distance apart of the two atmospheric lines. The diagram is thereby so distorted as to be valueless as an indication of what the engine is doing.

ARTHUR J. FRITH

Chicago, Ill.

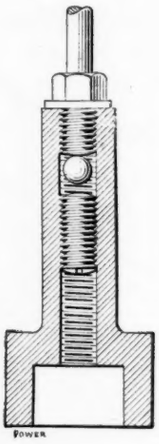


FIG. 2.

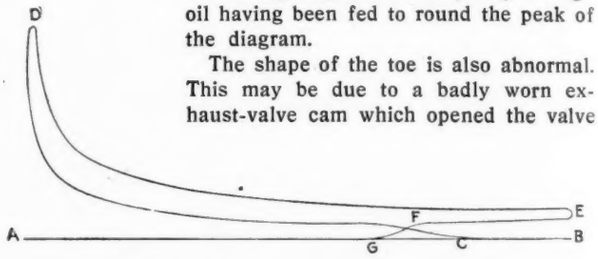


FIG. 4. MR. VANDERFEER'S DIAGRAM

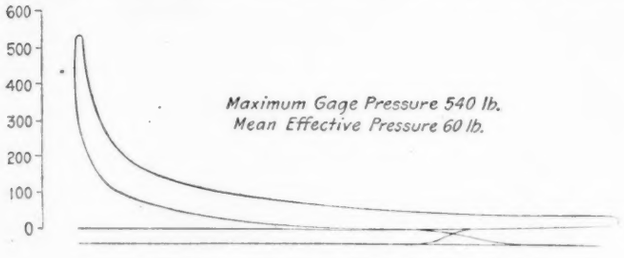


FIG. 1. MR. CATON'S DIAGRAM

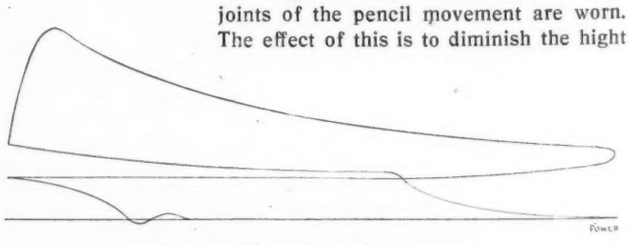


FIG. 3. MR. MUNRO'S DIAGRAM

Heating and Ventilation

Considered as power plant problems. Layout and operation of systems and apparatus

Heating Plant of the New York Public Library

By A. D. Blake

About three years ago, when the construction of the New York Public Library was well under way, the question of furnishing light and power came up for consideration. For a time a lively war was waged between the adherents of central-station service and those wishing an independent generating plant. The New York Edison Company was ready to furnish current for light and power at a maximum yearly cost of $25,000 if the consumption did not exceed 833,333 kilowatt-hours, and $21,600 if the consumption did not exceed 675,000 kilowatt-hours.

Fig. 1. Exterior View of Library

The heating of the building, however, proved to be the determining factor, and those in authority finally decided that an independent generating plant supplying exhaust steam to the heating system would be more economical than central-station service with a separate heating plant.

The total cost of the plant, exclusive of the wiring and heating ducts and pipes throughout the building, was $102,000.

Owing to the size of the building, representing a volumetric content of approximately 6,750,000 cubic feet, its exposed position and its many windows, a very interesting heating and ventilating problem was involved, and its solution forms one of the interesting features of the plant. The system was laid out on the basis of maintaining a room temperature of 70 degrees during zero weather.

The Heating System

The heating system is distinct from the ventilating system, the former being designed to merely take care of the radiation through the outside walls, while the latter changes the air at stated intervals.

In heating, the Paul system of direct radiation is employed, the radiators being placed along the outside walls of the rooms, taking exhaust steam from the engines and having a vacuum on the air valves. About 28,500 square feet of heating surface is thus supplied. A Johnston system of thermostatic control automatically maintains the desired room temperature.

The Ventilating System

The ventilating system consists of two divisions, the air supply and the exhaust. For the former, fresh air is drawn in from the courtyard, is filtered in passing through cheesecloth screens and is then passed over tempering coils located in the basement. These coils utilize exhaust steam from the engines and temper the air to the desired room temperature. On account of the bindings on the books it is desirable that the air be maintained at a certain humidity, and for this purpose moisture pans are placed at the bottom of the coils. After leaving the coils the tempered air is handled by three 12x6-foot and one 12x5-foot motor-driven Sturtevant fans (each 12x6-foot fan capable of handling about 75,000 cubic feet of air per minute) and is distributed

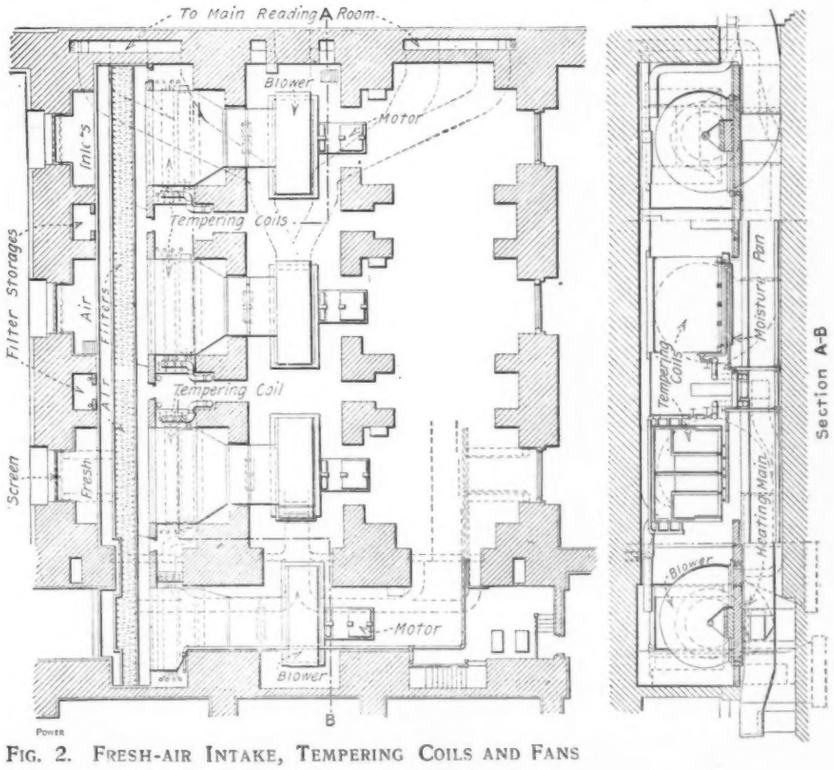


Fig. 2. Fresh-air Intake, Tempering Coils and Fans

through a system of ducts to the various rooms. Fig. 2 shows the arrangement of fans, filters and tempering coils and Fig. 3 is a view looking down the row of fans.

In the reading rooms the general scheme is to blow in this tempered air at or near the ceiling and to exhaust the impure air near the base. For the latter purpose a group of exhaust fans are located in the attic. A separate fan in the basement handles the ventilation of the engine room. In the stack rooms the supply and

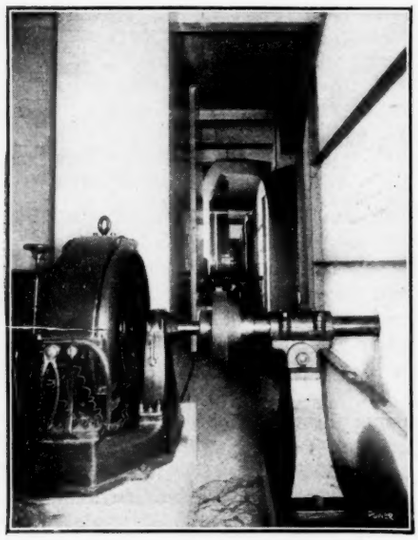


FIG. 3. ROW OF MAIN SUPPLY FANS

exhaust air ducts are contained in the ends of the book stacks, the supply being at the top and the exhaust at the bottom.

The system was designed with a view to changing the air three times an hour in the main reading room and two and one-

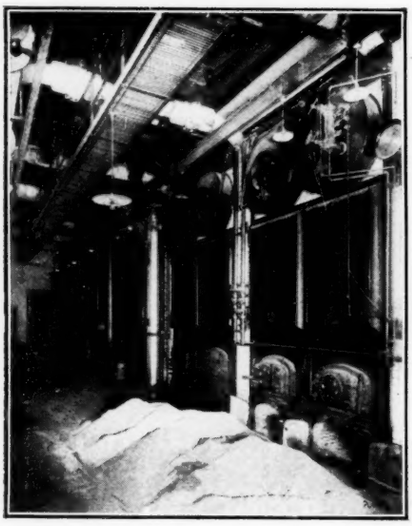


FIG. 4. BOILERS

half times an hour in the stack rooms. The other rooms throughout the building are changed six times an hour. It is also arranged in units so that any parts of the

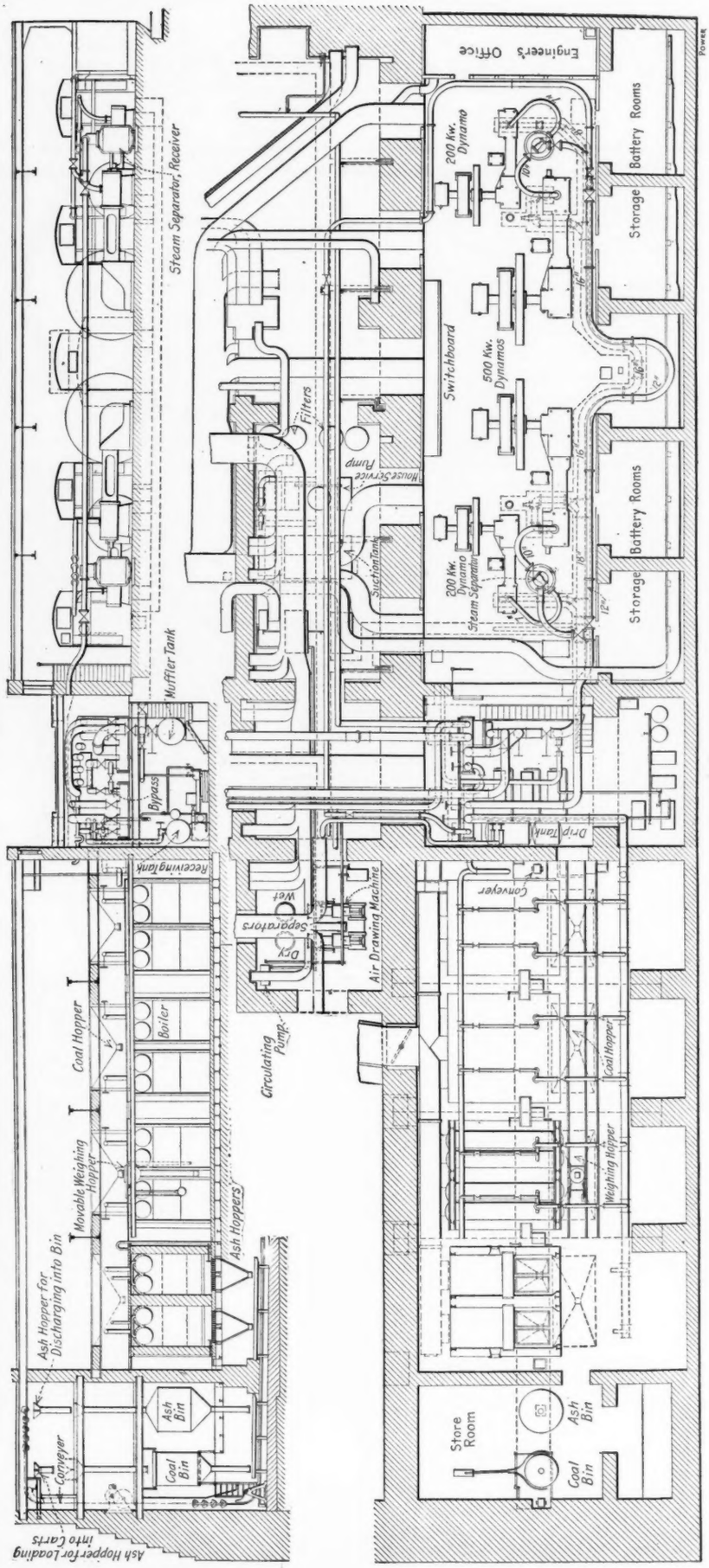


FIG. 5. PLAN AND ELEVATION OF BOILER AND ENGINE ROOMS

building not in use may be cut off from the heating service.

Boiler Plant

Steam is furnished at 135 pounds pressure by six 250- and two 240-horsepower hand-fired Babcock & Wilcox boilers, set in batteries of two each, as shown in Fig. 4. No superheat is used nor are economizers employed. The feed water is heated in a Berryman heater and is supplied to the boilers by two 7½x4½x10-inch Blake pumps. A section through the boiler room is shown in Fig. 7 and Fig. 5 is a plan of the boiler and engine rooms.

The method of handling the coal and ashes deserves special mention. Along the front of the boiler room and extending out under the sidewalk is a coal pocket of 150 tons capacity. Coal is dumped into this directly from wagons in the street above and is extracted as needed through doors opposite each boiler. A

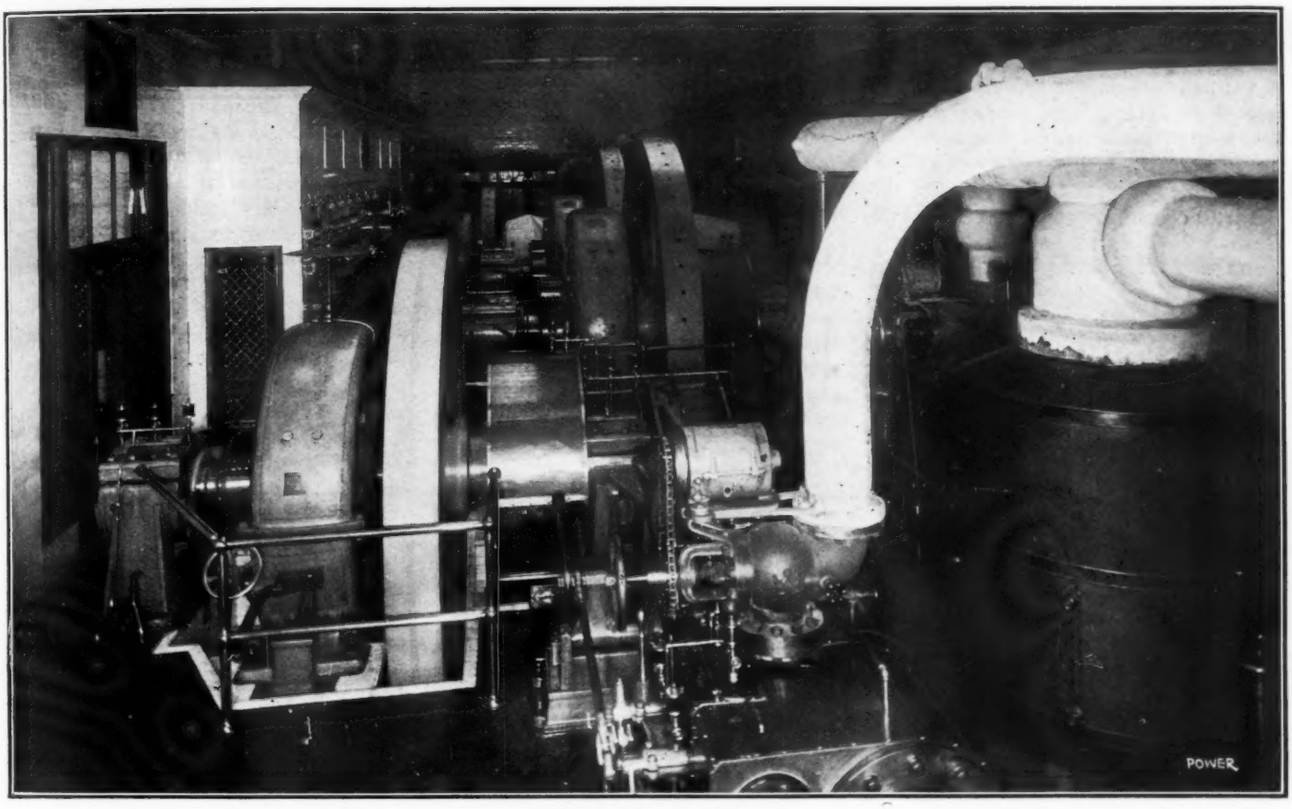


Fig. 6. Engine Room

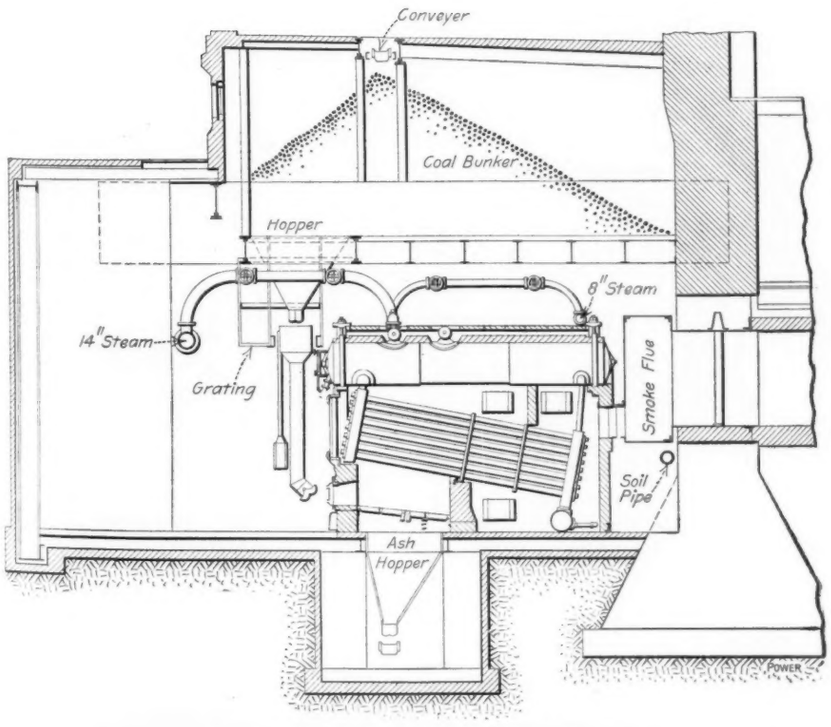


Fig. 7. Section through Boiler Room

second bunker is located over the boilers; this is of 600 tons capacity and discharges through hoppers in the front of each boiler to a traveling scales with chute attached. Coal for this bunker is dumped from the wagons into a weighing bin (see Fig. 5), from which it is discharged onto an endless bucket conveyer which passes under the row of boilers and then up over the coal bunker. This conveyer is also used for elevating the ashes from the hoppers under the ashpits and discharging either to an ash-storage bin or to the wagons direct.

The main 14-inch steam header feeds a 12-inch supply main to the engines. An auxiliary 8-inch steam loop is provided for use in case the main steam line is shut down for repairs or any other purpose. The main exhaust from the engines is 16 inches. Vanstone joints are used on all high-pressure piping over 5 inches in diameter.

Engines and Generators

Electricity for light and power is furnished by four units, two of 500 kilowatts and two of 200 kilowatts capacity, each consisting of a 250-volt Westinghouse direct-current generator, direct

connected to a single-cylinder, noncondensing Fitchburg engine, the larger ones running at 100 revolutions per minute and the smaller at 150. The engines exhaust into the heating system. As will be seen by reference to Figs. 5 and 6, the engine-room equipment is arranged in duplicate, one 500- and one 200-kilowatt unit being able to handle the load. In fact, during a large part of the time the smaller unit is able to carry the load. A 141-cell 800-ampere-hour storage battery of the chloride type supplies current for the night load after the reading rooms are closed. At such times live steam is passed through a reducing valve into the heating system, although in moderate weather the building remains reasonably warm and little live steam has to be used

Operation

It has been found convenient in actual operation to modify the use of the ventilating system from that originally determined upon. With the intake wide open and all the supply fans running, it was found that the tempering coils acted like a large condenser and that the engines carrying the usual load could not supply anywhere near the amount of exhaust steam needed; hence a large amount of additional live steam was necessary. Incidentally it was observed that with the fans shut down, the cold-air intake only partly open and the exhaust steam passing through the coils, a sufficient circulation was set up to keep the air in the rooms pure. The exhaust fans are kept in operation, of course, and greatly assist in this circulation. This practice has thus far been followed for a greater part of the time.

It is planned to use carbon-filament lamps throughout the building during the winter time, first, because of their relatively low cost, and, second, because the load is needed in order to supply the necessary exhaust steam. In the summer time tungsten lamps will be used.

According to the operating figures, electrical energy was produced last summer, when the exhaust steam was going to waste, for about 2⅝ cents per kilowatt-hour, and according to the present indications the cost per kilowatt-hour for the winter months will average close to 1 cent.

Of course, the plant has not been running long enough to obtain conclusive figures as to the cost of heating and the production of electrical energy at all seasons. However, last winter the heating plant was run alone without the engines, the high-pressure steam being passed through the reducing valve before supplying the heating system. The cost of heating under these conditions, which was approximately $100 a day (operating cost alone) during the winter months, will form an interesting comparison with the total cost of operating the plant during the coming season.

The electrical features of the plant were designed by Pattison Bros. and the heating and ventilating by Nygren, Tenney & Ohmes. The superintendent and consulting engineer is John H. Fedeler and the chief engineer is Louis Alt, who for a number of years was chief engineer of the old Astor Library.

LETTERS

Continuous vs. Intermittent Heating

The foreword in the November 7 number of POWER raised some very interesting questions in my mind, the most important perhaps being: Is it more economical to run the heating plant in a school building continuously? The amount of heat required for any building, of course, is equal to that which leaves the building. I think everyone will concede that more heat leaves a building when it is up to 70 degrees than when it is at 55 degrees. The question then becomes: Can this extra loss, when the building is up to 70 degrees, be compensated for in any way?

I mention the temperature of 55 degrees because it has been my observation that, when steam is turned off for the night, the temperature will at first drop rapidly, but by the time it has dropped 10 or 15 degrees, it will drop very slowly. This is evidently because, after dropping this much, the heat which passes from the walls, floors and furniture to the air of the rooms almost compensates for that which passes from the rooms to the outside. Much of the heat leaves a building through the windows and the solid materials of a large building store a large amount of heat.

My experience has also been that bringing the temperature back to 70 degrees in a few hours before the school session begins requires no extra boiler capacity. This is because, until the session begins, no air is needed for ventilation, and when air for ventilation is supplied, much more heat is needed to maintain a constant temperature.

I have never handled a low-pressure boiler, but I can see no reason why as much heat and as great a percentage of the total amount of heat cannot be transferred from the furnace gases to the water in a low-pressure as in a high-pressure boiler. The volume of steam from a low-pressure boiler is much greater, which fact leads me to ask the following: As usually installed, does the amount of liberating surface, the size of the steam pipe, or anything else, on a low-pressure boiler limit the boiler to less than a boiler horsepower from, say, 10 square feet of heating surface?

High pressure—that is, some surplus pressure—is an advantage in handling suddenly varying or intermittent loads, and is also an advantage to the fireman who wants to throw in a large fire and then leave the boiler for a long time; but is it any advantage, in heating, in handling a gradually varying load?

H. H. HASTINGS.

St. Louis, Mo.

The following data, obtained by W. C. Powell, engineer of the Waterbury Manufacturing Company, of Waterbury, Conn., some years ago, have a direct bearing on Mr. Hastings' questions. The engines were operated condensing from Manning boilers under very high pressure. The heating was done by means of horizontal tubular boilers operated at 50 pounds pressure, so that the system was entirely distinct and separate from the power boilers. Mr. Powell's report runs as follows:

"We have a factory containing 20,710 square feet of radiating surface for heating purposes, about 20,000 of which has been in use for the past five weeks, during which time we have kept a record of the coal burned and the temperature of the outside atmosphere. According to our record, when the thermometer averaged 42 degrees during the day we required 4200 pounds of coal per 24 hours and when it averaged 22 degrees we required 8100 pounds of coal. In our horizontal tubular boilers we extract 8500 heat units per pound of coal, which amount is transferred to the hot water, the balance of the heat in the coal being lost.

"The average temperature for the five weeks being 33 degrees and the average coal consumption 5400 pounds, we will consider these conditions constant, as it will materially lessen the complication of figures, and give an approximate result sufficiently close to guide us in operating this system. Multiplying the pounds of coal by the heat extracted per pound,

$$5400 \times 8500 = 45{,}900{,}000 \text{ } B.t.u.$$

per 24 hours were obtained, or 1,912,500 heat units per hour radiation from the system, which also represents the radiation from the factory to the outside atmosphere under these conditions. If the factory were shut down as far as heating is concerned, 19,125,000 heat units would be radiated to the outside between 6 p.m. and 4 a.m., and

$$10 \times 1{,}912{,}500 = 19{,}125{,}000 \text{ } B.t.u.$$

would be saved.

"In the morning we would have to raise the temperature of the factory to 70 degrees again in three hours. When the source of heat is shut off the radiation diminishes as the temperature inside decreases. The air space in the factory is approximately 1,600,000 cubic feet and were the building empty, the temperature would go down quite rapidly as the air would contain 2,011,730 heat units. We must consider that the

contents of the buildings have to give up their heat as the inside temperature diminishes. The fire-extinguisher pipes are full of water at 70 degrees and must radiate their heat to the factory, as well as the hot water in the heating pipes, as soon as the temperature begins to fall. The same is true of all machinery, tools and metal of all description. The wood work, floors and posts and all contents must give up their heat which tends to keep the temperature up inside, as an immense amount is stored up in this manner. It also has to be replaced before the room is at 70 degrees again.

"It is reasonable to assume with a difference of 37 degrees between the inside and outside, that the inside temperature will not fall below 60 degrees in the factory in 10 hours' time between 6 p.m. and 4 a.m., and this has been demonstrated by observation many times. To ascertain what amount of heat has been stored up in the contents of the building and has radiated, it will be necessary to know the amount of coal or steam required to raise the temperature from 60 to 70 degrees. This we have found by letting the temperature of the factory fall to 60 degrees and weighing the coal required to raise it to 70 degrees. This has been found to be 3000 pounds, which, multiplied by 8500, equals 25,500,000 B.t.u.

"Had we kept the factory at 70 degrees temperature all night we would have burned 2925 pounds of coal to furnish the loss by radiation for 13 hours from 6 p.m. to 7 a.m. This therefore proves that there is no saving by shutting off the heating system at 6 p.m. and then overtaxing it early in the morning. The difference in coal in favor of operating all night is 75 pounds, or 2½ per cent."

Taking 34 pounds of water per boiler horsepower and 1000 B.t.u. per pound of steam, the boiler horsepower required to be operated continuously would be,

$$\frac{2925 \times 8500}{13 \times 34{,}000} = 56.3 \text{ horsepower}$$

If operated for three hours, the required capacity would be

$$\frac{3000 \times 8500}{3 \times 34{,}000} = 250 \text{ horsepower}$$

or four times the horsepower required when run continuously.

IRA N. EVANS.

New York City.

A Water Heater Problem

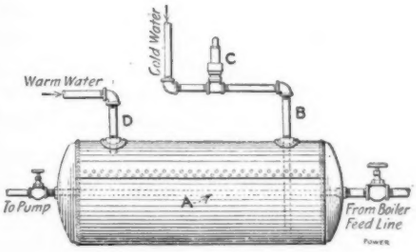
Having been called upon to make some arrangement for furnishing warm, not hot, water for the office force in the factory where I have charge of the engine and boilers, I commenced to formulate some plan that would be efficient, simple and yet fill the requirements.

First we considered a tank with a steam coil inside, but soon realized that the water, unless used as fast as heated, would soon get nearly as hot as the steam; also, a steam-reducing valve would be necessary and some means, such as a trap, would have to be provided to save the condensation. This meant too much complication and the method was discarded.

Thermostatic control, in order to keep the water at a medium temperature, was next considered, but the disadvantages were about as numerous as in the first case.

An arrangement for heating the water with gas was also given some attention, but the amount of gas consumed with the problem of keeping the "pilot" burning at all times turned us against it.

Another plan was to draw the water directly from the boiler-feed line. This



WARM-WATER TANK

was quickly decided against, for the water would be too warm, also more or less unclean as it came from the heating system.

The plan shown in the accompanying illustration was finally adopted. As may be seen in the illustration an ordinary 12x30-inch galvanized-iron expansion tank was provided with openings in each end for 1-inch pipe. A ¾-inch brass pipe *A* was run through the tank, one end of the pipe being threaded into a ¾x1-inch bushing which was screwed into one end of the tank. The other end of the pipe, in order to allow for contraction and expansion, was packed with soft packing and held in place by a check nut screwed on the pipe.

One end of this pipe was connected to the boiler-feed line after it left the feedwater heater. A valve was placed on the line so that the amount of hot water passing through the pipe in the tank could be regulated according to the desired temperature and quantity of warm water required in the office.

The outlet end of the pipe was connected to the pump receiver. With these connections there is very little loss of heat, for only enough water is shunted through the tank to warm up the office supply to the desired temperature.

A valve is placed in the outlet and is kept wide open so as to have no appreciable pressure in pipe *A*. While with this arrangement the tank can be heated only when the pump is running, the tank is of ample capacity so that enough water is in storage to supply the demands of the office force when the pump is not in action.

In the sketch, *B* represents the cold-water supply to the tank. A small relief valve *C* is installed on the water supply to protect the tank against the expansion of the water.

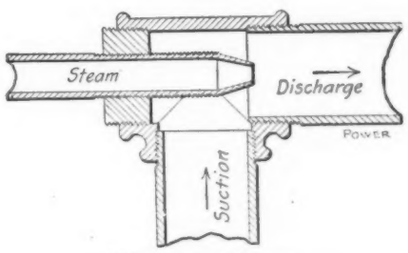
Pipe *D* is the warm-water outlet leading to the toilet rooms. To save needless waste of water, the tank is placed as near the toilet room as convenient, so that only a small amount of water needs to be drawn before the warm water in the tank is available.

N. C. RICE.

Springfield, Mass.

A Homemade Siphon

Where there is danger of the sewer backing up into the pit containing the



HOMEMADE SIPHON

pump and receiver on the heating system, a homemade siphon can be installed at very small expense. Take an 8-inch length of ½-inch pipe with one end tapered for 1 inch. Cut a running thread on the tapered end, and screw it into a 1¼x½-inch bushing so that the nozzle will extend into the discharge pipe on the opposite end of the tee about ⅛ inch. On the other end of the 8-inch piece of pipe cut a standard thread for an elbow so that a globe valve may be inserted in the line to regulate the supply of steam to the siphon. It is also necessary to have a union in the line placed between the valve and the siphon.

LEWIS A. DANNER.

Chicago, Ill.

Measurement of Air Velocities

Referring to the article by F. G. Heckler in POWER of August 29, in Fig. 2 he illustrates an arrangement of Pitot tubes whereby he alleges he can secure accurate readings of the velocity of air passing through the pipe. His readings would be inaccurate if made with the static tube at *A* projecting into the pipe as shown. To determine the static pressure the connection must not project but must be flush with the inner wall of the pipe.

A. H. ANDERSON.

Chicago, Ill.

The first freight steamer propelled by Diesel oil engines to cross the Atlantic recently arrived at Montreal, Canada. The voyage was made from the Tyne to the St. Lawrence in 26 days.

Boiler Explosion in England Kills and Injures Many

By the explosion of a boiler in the oil-cake mills of J. Bibby & Sons, at Liverpool, England, on November 24, thirty-three workmen were killed and upward of 100 others were injured.

At the time of going to press only very meager details could be obtained and it was impossible to ascertain the cause for the explosion.

Nearly 400 workers were in the building at the time and everyone was thrown to the ground by the violence of the explosion. It is reported that many in the vicinity of the boiler room had their legs literally torn off, and their mangled bodies fell into the adjoining streets together with heavy showers of brick and débris.

Following the accident the whole building burst into flames and was soon blazing fiercely.

A special representative is getting the story for POWER and the details will be published as soon as available.

Fatal Piping Accident at Scranton

A most unfortunate accident occurred at the Scranton Electric Company's plant, Scranton, Penn., on Sunday morning, November 19, which resulted in the death of two men and the serious scalding of three others.

These men were employed by the New England Engineering Company and were engaged in making extensions to a 22-inch exhaust-steam pipe. This pipe was coupled to one of the new reciprocating engines and was connected to a main heating pipe which was run to the business section of the city and furnished steam for commercial heating. The exhaust pipe ended with a 22-inch tee, the outer end of which was capped with a blank flange.

It was the intention of the men to secure a nipple to the tee and extend the pipe to a second engine with connections so arranged that either or both engines could exhaust into the heating main or one could exhaust into the heating main and the other to the atmospheric-exhaust pipe. The pipe was in the basement and the tee came in a narrow space between the engine foundation and the basement wall. This made it almost impossible for the men to escape when the flange blew off.

Just why the men should remove the flange from the end of the tee while steam was on the pipe, is not known. The officials of both the Scranton Electric Company and the New England Engineering Company are reticent and therefore no information can be obtained from them. It has been ascertained that a live-steam pressure of about 8 pounds per square inch was on the line at the time of the accident as the engine connected to the exhaust pipe was not in operation, the live-steam being used to do the necessary heating.

Owing to some misunderstanding or not knowing that the steam was not turned off, the men doing the work removed the nuts from the flanged bolts and the blank flange was then blown off.

It is rumored that the men were told that the line was dead, but this cannot be verified. From newspaper reports, it is stated that Inspector Flint, of the boiler-inspection department, declares that the dead and injured men were guilty of contributory negligence, but it would appear that the regular employees of the plant should have made certain that the steam was turned off before allowing anyone to work on the piping.

New Haven Meeting of the A. S. M. E.

The members of the American Society of Mechanical Engineers residing in and about New Haven have organized for the purpose of holding local meetings, the first of which was held at the new Mason laboratory of Yale University on November 15.

It was fitting that this meeting of mechanical engineers should be the first public use made of the auditorium of this laboratory of mechanical engineering, which has just been completed under the direction of Prof. L. P. Breckenridge, and had been used by the classes of his department for about a week.

The topic of the meeting was "Cost of Power" and the following papers were presented:

"Cost of Power with a Small Gas-producer Plant," by Hunnewell.

"Cost of Power with a Small Hornsby-Ackroyd Oil Engine," by Professors Pfleghar and Lockwood.

"Small Steam Turbines," by A. W. J. London, of the Terry Turbine Company.

"The Hartford Electric Light Company, Its Power Plant, Distribution System and Public Service," by Charles F. Scott, professor of electrical engineering, Sheffield Scientific School.

The oil-engine paper appears in this issue, page 855, and the others will receive attention in due season.

The meeting was divided into an afternoon and an evening session, the three papers first named being presented and discussed in the afternoon. The evening session was addressed by President E. D. Meier, who commended the undertaking of such local meetings of the society and told of movements in that direction in other parts of the country.

Between the sessions the facilities of the Yale Dining Club were made available to those attending the meeting, and the laboratory was open for inspection before and after the sessions.

E. S. Cooley, of the Connecticut Company, and chairman of the committee having the local meetings in charge, presided at the afternoon session and Prof. L. P. Breckenridge presided in the evening.

The Mechanical Engineers

The fall meeting of the American Society of Mechanical Engineers will be held at the Engineering Societies building, New York, December 5 to 8. The president's address will be made on Tuesday evening, followed by a reception. The annual business meeting will be held Wednesday forenoon, at which time will also be found for papers upon the following subjects:

"The Turret Equatorial Telescope," by James Hartness.

"Expense Burden," by Sterling H. Bunnell.

The Wednesday afternoon session will be devoted to boilers with two papers:

"Tests of Large Boilers at the Detroit Edison Company," by D. S. Jacobus.

"Strain Measurements of Some Large Boilers under Hydrostatic Pressures," by James E. Howard.

The papers of Messrs. Jacobus and Howard are to be found in abstract on pages 840 and 845 respectively.

A session will be held concurrently to consider papers dealing with the manufacture and use of cement.

A reception will be given by the ladies' committee from 4 to 6.

On Wednesday evening, Dr. Robert Simpson Woodward, president of the Carnegie Institute, of Washington, will deliver a lecture on "Geo-Dynamics, or the Mechanics of the Formation of Worlds."

Thursday's papers of the main society deal largely with machine-shop practice, the one which may interest POWER readers being, "A Variable-speed Power Transmission," by G. H. Barrus and C. M. Manly.

The Gas Power Section, however, will hold its session on Thursday forenoon and will discuss the following papers:

"Oil Engines," H. R. Setz; "Tests of an 85-horsepower Oil Engine," Forrest M. Towl; "Design Constants for Small Gasolene Engines," William D. Ennis; "Natural-gas Engine of 1000 Kilowatts, Tests, Construction and Working Costs," E. D. Dreyfus and J. V. Hullquist, an abstract of which will appear in an early issue.

On Thursday afternoon the members of the society are invited by the White Star line to inspect the SS. "Olympic," the largest passenger steamer afloat. The usual reunion will be held at the Hotel Astor in the evening.

At the Friday morning session no papers will be presented of special interest to power-plant engineers.

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POWER

Pipe Bends

It has already been mentioned from time to time in the editorial columns that of all parts of a pipe line the fittings should be the strongest. The reasons for this are many, but perhaps the most important of them is the severe strain to which they are subjected by the expansion and contraction of the piping. This action, which always obtains in all steam piping, is practically impossible to overcome and in time is liable to have a deleterious effect upon the fittings. For this reason it has become quite customary to install fittings of cast steel for high pressures and extra-heavy cast-iron ones for the more moderate pressures. There is also danger from gaskets blowing out, as well as the annoyance and economical loss due to leaking joints, etc. These points are now receiving more and more consideration by engineers when laying out new installations, with the result that, wherever possible, pipe bends are resorted to quite extensively.

This method for getting around corners, etc., is not at all new, however, for it was not many years ago that the multiplicity of fittings now available for pipe lines could be obtained, and there are many old pipefitters yet living who can look back to the time when crooks and turns in a pipe were made by bending it with practically no other tools than two deft hands. Those were days of comparatively low steam pressures and the advent of fittings was doubtless hailed with much satisfaction. The greater steam and water pressures now demanded, however, make the cast-iron elbows more or less unsafe; consequently the pipe bend has again returned.

In addition, there is the fact that pipe bends are very little, if any, more costly to install than fittings. In the first place, good practice demands that a long-sweep ell of ample weight and strength be used and to the expense of this must be added the cost of two gaskets—probably of copper—two sets of bolts, cutting the thread on one end of each of two pipes and, added to all of this, the cost of the labor required to make up the two joints. By totalizing all of these items it will be found that the cost will probably be equal to, if not more than, the cost of bending the pipe. Furthermore, the use of pipe bends would effect a saving in the cost of the pipe covering as well as in maintenance. Some slight saving in the pipe would also result as less is required in making the bend than when using an ell.

In laying out a piping system with wrought bends, it is important to use the longest radii that conditions will allow because, first, it will permit a more free passage for the steam, and, second, the bends can be more easily and cheaply made. The minimum radius should not be less than six times the nominal diameter of the pipe for sizes from three to six inches inclusive, and from three to four times the diameter for the smaller sizes. For sizes above six inches the minimum radius should never be less than seven times the diameter. By adhering strictly to such limits there is no danger of so stretching the material that it will become attenuated or oxidized and thereby lose its strength. Pipe as large as twenty-four inches in diameter has been successfully bent to a radius of eighteen feet.

The Delray Boiler Test

Never before has so remarkable a test of so remarkable a pair of boilers been conducted as that reported upon page 840 of the current issue.

The boilers at the common rating of ten square feet of heating surface per horsepower have a capacity of 2365 horsepower in a single unit, and each will in connection with the turbine-driven generator which it supplies produce 6000 kilowatts of electricity regularly and from 7000 to 8000 in the evening. The furnace is 26.5 by 14 feet, and with the inclined grate has a fuel surface of 405 square feet in one case and 446 in the other.

The tests extended over a period of

nearly three months, and for six weeks over fifty men worked in eight-hour shifts, day and night, exclusively upon them, the average quantities handled hourly being eight tons of coal, seventy-five tons of feed water and a ton of ashes. The evaporation was carried to 214.8 per cent. of the normal capacity and the efficiencies exceeded eighty per cent. in several tests and never fell below seventy-five in the reported results.

The efficiency on the maximum forcing test above referred to was 76.18, with the flue gases leaving at 668 degrees. The radiation and unaccounted-for losses are very small, averaging below three per cent.

Unless unforeseen difficulties of maintenance and operation develop, it is likely that the great turbine units now available will be served by boiler units of correspondingly increased capacity.

Small Rope Drives

Study of the reports on rope drives in foreign countries and observation of the extent to which cotton rope is there used for small drives lead to the belief that there is a field for the use of rope in this country as a medium of transmission between main and counterdrives and even between the counterdrives and the machines. It does not seem unreasonable to assume that by the use of pulleys and ropes of proper size economies could be effected over the use of belts. The rope is capable of a more uniform drive because of the reduction of slip, its first cost is lower and, due to the decrease in the necessary width of pulley, it requires less room for proper operation. Further, owing to the much higher speed of travel permissible with rope, the total efficiency of the rope drive may be much increased over that of the belt drive and the wear and tear on the shafting reduced, owing to the decreased weight of the driving pulleys.

It seems a pity that the practice which has proved so successful in drives of this character is not carried further into the smaller types of drive, using cotton ropes in diameters of from 1 to ½ inch, and replacing the smaller sizes of belt. In this country cotton rope has not made a very great success, largely owing to its first cost; but abroad the cotton rope is quite successful for both long and short drives and also for the smaller sizes of drive.

It is reported from time to time that a rope drive has been replaced, owing to the ropes wearing out and thereby giving trouble. This wearing out is doubtless the result of two causes:

First, rope made of material not thoroughly well adapted to driving, and not susceptible of much bending without a material distortion and destruction of the fibers. The fibers being hard, they inevitably cut one another, resulting in a rapid destruction of the rope, particularly if it is used over pulleys of small diameter.

Second, the employment of sheaves or pulleys not adapted for use with the ropes that are run upon them. It has been found by repeated experiment that ropes of different materials require grooves of different shapes, and that under different conditions of drive the grooves may have to be varied over considerable ranges, using either flatter or sharper grooves, in accordance with the character of the drive. It is, therefore, necessary in order to have a successful and economical drive, first, that the rope be of a material properly adapted to the purpose; and, second, that the sheaves be properly adapted both to the rope and to the conditions of drive.

Condensing Water Doing Double Service

At the Canton, O., electric-light station they are planning to use the condensing water in two temperature stages. It comes from driven wells at a temperature of about fifty-one degrees. They will use it first in the condenser for the steam turbine and obtain a good vacuum by keeping the temperature of the circulating water down to eighty or ninety degrees. It will then go to the condenser of a piston engine, where it will readily maintain the twenty-six-inch vacuum desired.

This is one of the few stations which can draw a plentiful supply of cold condensing water out of the ground under the station and let it run away in a brook when they have finished with it.

There are more factors to deal with in estimating the safe working pressure of a boiler than the stress on the longitudinal joint and its efficiency. See other pages of this issue.

Safety in the Boiler Room

In Germany, no shell boiler nor water-tube boiler having drums is allowed to be set under occupied workrooms or premises. Where the floors above are occupied, water-tube boilers without drums are used. In all boilers the furnace doors and other openings must be safe against opening by pressure within the furnace and a passage from the interior of the furnace to the outside air must be provided for the steam in case of the rupture of a tube. Such precautions would reduce the number of fatalities from tube bursts now so common in this country. The suggestion is submitted for the prayerful consideration of designing engineers, power-plant owners, boiler-insurance companies and government boards of boiler control.

One chronic kicker in an engine or boiler room is like a bad apple in a barrel of good ones; it makes all the others feel rotten.

The Ohio Society of Mechanical, Electrical and Steam Engineers has just celebrated its tenth birthday. May its second decade be as creditable and successful as its first.

To know how the "other fellow" does things is best learned by paying a visit to your neighbor's plant occasionally. You may be able to tell Mr. Neighbor a thing or two as well.

That POWER's "foreword" page sometimes has a financial as well as educational value is instanced in a letter recently received from an engineer who framed the foreword "Hope" (in the September 26 issue) and hung it in the engine room. The manager read it and the engineer got a raise of $3 a week.

Mr. Bailey's paper on "The Fusing Temperature of Ash" suggests the idea that grate and clinker troubles may be avoided by running the fuel bed as far as possible as a gas producer and burning the gas in the combustion chamber. In other words, keep the fire bed at as low a temperature as is consistent with gasifying the amount of coal required; avoid melting the incombustibles, and develop the heat mostly above the surface of the fuel.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Reducing Valve in Steam Main

Many concerns are putting up good buildings, but their power-plant equipments are far from being efficient; not only is the selection of the machinery and equipment at fault, but the general layout and construction are not up to the standard.

The example cited herewith is taken from such a plant in which there is a 12x30-inch Corliss engine. On the steam line leading to this engine is a reducing valve which reduces the pressure from 100 pounds to a lower pressure before entering the cylinder of the engine, the

FIG. 1. LIGHT-LOAD DIAGRAM

FIG. 2. DIAGRAM AFTER LOAD HAD BEEN INCREASED

idea being that this effects a saving with light loads on the engine.

There is very little use in buying a Corliss engine and then putting a throttling governor on it. One of the main features of this engine is the high initial steam pressure and a sharp cutoff and expansion of the steam. Putting an obstruction in the main steam pipe to prevent an engine from working economically is a piece of nonsense. By lowering the steam pressure with the reducing valve the engine will carry the steam further in the stroke and cause a much later cutoff and less expansion. These conditions lack economy, bring the Corliss engine nearer to a working level with the common throttling engine, and lose all the points of merit which the Corliss engine possesses when properly operated. This plant is not economical in its operation.

The accompanying diagrams, Fig. 1, show the working of this particular engine at light load and would lead one to believe that they came from a common throttling engine. The diagrams shown in Fig. 2 were taken from the same engine under an increased load. The features of the diagrams are as bad as the steam-pipe arrangement. One end shows a late admission and a leaky exhaust valve, and the opposite end might be recognized as coming from a Corliss engine, but as a whole one could not find a steam plant working under worse conditions. The plant has every appliance one could think of, but the steam mains leading to the engine and pumps were uncovered.

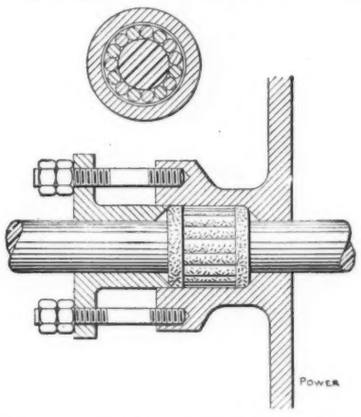
C. R. MCGAHEY.

Baltimore, Md.

New Way of Packing a Stuffing Box

Some time ago I had trouble with a leaking stuffing box, and was unable to prevent the leakage owing to the scored condition of the piston rod.

I finally remedied the trouble by putting one round of packing in the stuffing



SECTION THROUGH STUFFING BOX

box in the usual way. I then cut enough lengths of packing to go around the piston, as shown, each strip being cut to the full length of the stuffing box. Graphite in paste form was applied to each piece, and the gland tightened to press the packing, after which the gland was loosened and another round of packing was inserted in the stuffing box.

I have used this method on air compressors and duplex pumps, and also on centrifugal pumps when the shaft has been worn or grooved.

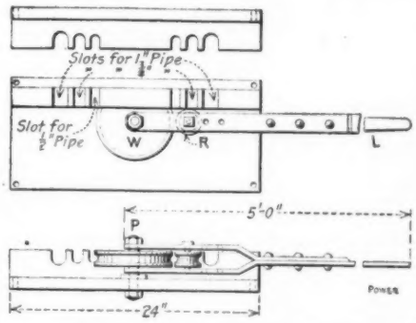
C. W. IBACH.

San Pedro, Cal.

Pipe Bender

The accompanying sketch shows the details of a conduit bender I made to bend ½-, ¾- and 1-inch conduit elbows. The base is a cast-iron plate 1¼ inches thick, 12 inches wide and 24 inches long which can be fastened to a bench or wall. The lever *L* is about 5 feet long and is made of ½x2-inch machine steel. The pivot *P*, on which the half wheel *W* and lever are mounted, is made of cold-rolled shafting, turned down to 1 inch, with a collar next to the plate.

In the sketch the bender is shown rigged up for bending ½-inch conduit. For bending the larger sizes the half



DEVICE FOR BENDING PIPE

wheel is changed for another having a larger diameter and the roller *R* is moved out further on the lever.

For bending ½-inch elbows I use a half wheel having a minimum diameter of 7⅝ inches, for ¾-inch pipe a minimum diameter of 9⅝ inches, and for bending 1-inch pipe a wheel having a diameter of 10⅞ inches. The small roller is used for all three sizes, but its position on the lever is changed.

To bend the pipe, place it in the slot between the wheel and the roller; the lever is pulled around through a little more than 90 degrees, as there is always a little spring to the pipe, and the bend is completed. No clamping of the pipe is necessary as the binding action of the lever will hold the conduit in the position in which it is placed in the slot. With this bender uniform bends are assured.

Bends made with a "hickey" are satisfactory where no uniformity is required, such as in concealed work or in making bends on conduit already in position where a bender could not be applied. But for exposed work, where neatness and appearance count, it requires considerable skill and time to make all of the bends uniform with a "hickey,"

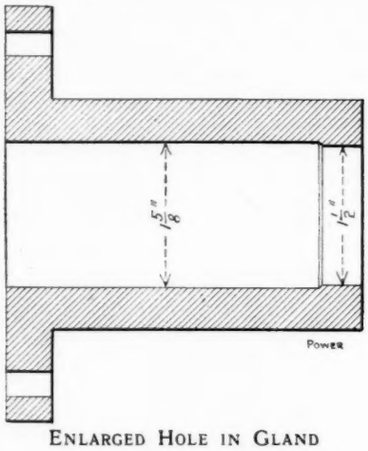
whereas with this bender anyone can quickly and easily make the bends with every assurance of their being uniform.

P. JUSTUS.

Cleveland, O.

Enlarged Hole in Stuffing Box Glands

Friction and scoring of piston rods, valve stays, etc., can be reduced by boring the stuffing-box glands as shown in this sketch.



ENLARGED HOLE IN GLAND

GEORGE R. WILLIAMS.

Findlay, O.

Oil Fired Furnace

The accompanying sketch shows the principal dimensions of an oil-fired furnace for an 18-foot by 72-inch return-tubular boiler. The walls are built without any air space and are 30 inches thick at the base. The furnace at the grate level is 60 inches wide, or 12 inches less than the diameter of the boiler. The side walls on the inside are built sloping, as shown, so that they clear the shell 4 inches at a point level with the center of the boiler, and are racked in to within ½ inch of the shell at a point level with the center of the top row of tubes. The space between the brickwork and the shell is filled with asbestos rope.

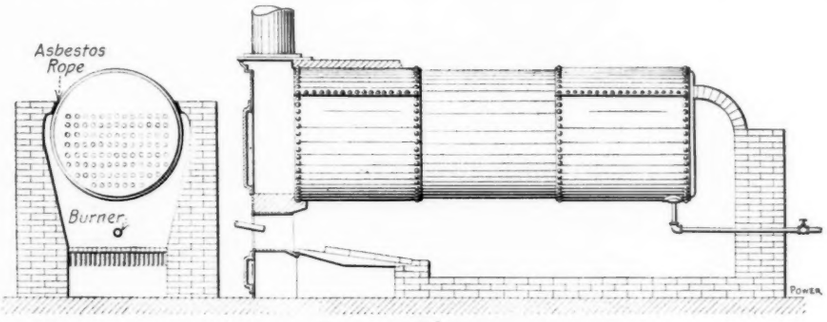
This construction insures exceptionally long life to the lining of the furnace. The lining of an oil-burning furnace above the grate is not subjected to the rough usage necessary to remove the clinkers, as is the case when burning coal or lignite, but as oil-fired boilers are usually operated at higher rates of evaporation than when burning coal, the higher temperatures incident to such crowding must be taken care of. Although this narrow furnace might be objectionable with some fuels, it is very desirable when burning oil.

The entire lining of the furnace should be of firebrick, rubbed in with a thin batter of fireclay and a header with every fourth course.

The grates are of the stationary type usually used with coal, the front end being set 30 inches from the shell and the rear end 8 inches lower. The grates are partially covered with firebrick, leaving a strip 12 inches wide at the front end for the admission of air.

No bridgewall or spatterwall is used. The combustion chamber is paved with three layers of brick, laid flat, without mortar. The rear wall is 24 inches from the rear head. The burner is placed in the front end between the doors, 8 inches above the grates, and is set so as to throw the fire slightly downward.

Some of the advantages of this construction are as follows: There is nothing to cause the flame to impinge directly against the shell of the boiler; therefore there is no danger of injury to the sheets by the intense local heat.



FUEL-OIL FURNACE

The flame is kept away from the shell as much as possible, and as the brick in the bottom of the combustion chamber become incandescent when the furnace is in operation, a high temperature is maintained throughout the entire combustion chamber, a condition that is very necessary to secure economical combustion.

Having no checker work, the furnace is easily accessible, thus permitting a thorough inspection of the boiler without removing any of the brickwork.

J. T. WLLIAMS.

Brownsville, Texas.

Losses in Unalined Shafting

Engineers and superintendents who have never given special attention to the matter of unalined shafting as a source of power waste must have been surprised by Mr. Kieffer's article of October 10. Many readers, previous to their perusal of this article, had doubtless never dreamed that conditions of waste through shafting alone could exist to the degree described, yet the line shafting in many mills and factories is a fruitful source of prolific waste and in many cases unsuspected by the management.

I know of a case where a new factory had been built and operated for four months. It was then idle four months and again started. In the meantime the green timbers and posts used in the mill construction had dried out and the piers supporting the posts to which the shafting was attached had settled.

I took charge of the steam plant about this time and found the frictional indicated horsepower greatly in excess of what it should have been for this size of mill. This was plainly attributable to the line shafting, and an investigation was made.

The main-line shaft, 200 feet long and from $5\frac{15}{16}$ to $2\frac{7}{16}$ inches in diameter, was found at one point to be down ⅞ inch and up ⅜ inch in 20 feet, and nearly as bad at other hangers. It was out of level $1\frac{7}{8}$ inches in its total length and equally as much out of line.

When this was corrected a difference of 40 horsepower less was made under the same load conditions, in a total of 400 horsepower.

Conditions equally as bad, no doubt, obtain in older factories, and if the horsepower excess were to be figured down to the coal pile at so many pounds per horsepower-hour, some startling figures would result.

F. C. HOLLY.

Yazoo City, Miss.

Step Bearing Pump Regulator

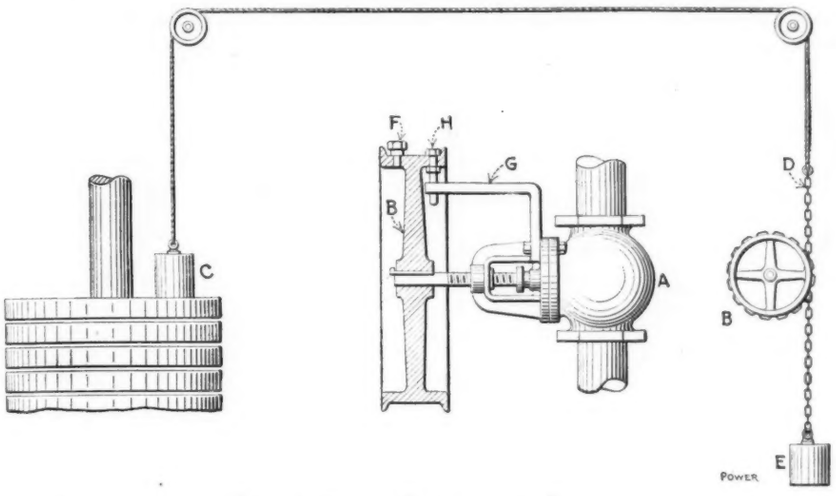
The illustration shown herewith is of an automatic regulation I have been using in a 4000-kilowatt, two-unit plant for over three years with entire satisfaction.

On the steam line of the step-bearing pump, and above the hand throttle, is placed the automatic throttle *A*, which is fitted with a pulley *B*. From the weight *C*, on the accumulator, a ¼-inch wire cable runs over suitable sheaves to the point *D*. About 8 feet of flat-link chain is fastened to the cable at *D*; and is run once around the wheel and bolted to the pulley at F and terminates at the weight *E*.

A little experimenting with the accumulator up and the pump running will determine which link of the chain the bolt *F* must pass through to hold the accumulator at a point that is a safe distance below its positive stop.

The pulley stop *G* is fastened to a stud of the valve bonnet or other suitable place; and so placed, in reference to the position of the stop bolt *H*, that the two will come in contact when the throttle is

almost one turn open, and again when it is shut. The throttle should be of sufficient size to enable the pump to hold the accumulator up at the lowest working steam pressure, when operating within the limits of the pulley stop.



REGULATOR FOR STEP-BEARING PUMP

The pump is started up and shut down by the hand throttle. The regulating valve requires no attention after being once properly set.

W. E. BERTRAND.

Philadelphia, Penn.

Steam Gage Stuck

The plant in which I was head fireman on the night shift had five water-tube boilers, all connected to one header.

On Saturday evenings the day man would cut out one boiler for washing on Sunday. It was my place, Sunday night, to head up the boiler and get it fired up and cut in with the rest.

This Sunday night I went at the job as usual, built a fire under the dead boiler after putting in two gages of water. I had about 75 pounds pressure on the other boilers and after a reasonable time the gage of the boiler I was firing up showed the same pressure. I was about to go up over the boiler and cut it in with the others when both safety valves blew, although they were supposed to blow at 125 pounds pressure. I pulled my fire out at once and put on another steam gage, which indicated 140 pounds pressure. The old gage had been all right on Saturday evening, but for some reason it would not show over 75 pounds pressure on Sunday. Shortly after this the inspector inspected the plant and cut the pressure down to 110 pounds per square inch. Had the safety valves not blown, the boiler would doubtless have exploded.

One cannot be too careful about a steam plant.

HAROLD J. WILKINSON.

Angola, Ind.

Cause of Apparent Click in a Cylinder

In the plant where I am employed there was recently installed an automatic engine stop. The automatic stop valve, which is situated above the throttle valve, has a 1-inch drip pipe leading from it to a 3-inch pipe which takes the discharge from an ejector and a steam trap to the sewer.

After installing the engine stop I got an occasional click which seemed to come from the cylinder. It would appear two or three times in succession and then disappear for an hour or so and then come again a few times. I concluded that since there was no noise in the cylinder before installing the automatic stop that it must in some way be caused by it.

For a trial I disconnected the automatic stop-valve drip from the ejector-discharge pipe, plugged the discharge pipe and left the drip open to the atmosphere. I had no further click in the engine, and presume that the noise was caused by water hammer in the automatic valve drip pipe whenever the ejector or the trap operated.

FREDERICK M. PERRAS.

Mansfield, Mass.

Polishing Round Brass and Steel

It is often necessary to resort to emery cloth in order to clean badly corroded or tarnished brass, steel rail posts, rods, etc., and this becomes real labor when there is much to be done. However, this work may be rapidly and easily accomplished by wrapping the emery cloth or paper tightly around the rod to be polished. Then take a couple of turns of heavy waxed cord or, better still, some broad tape around the emery cloth. Grasp the two loose ends and by alternately pulling them the emery cloth may be made to revolve rapidly about the rod and the polishing is accomplished in a short time. Do not use too coarse emery as this will leave scratches and make a rough job.

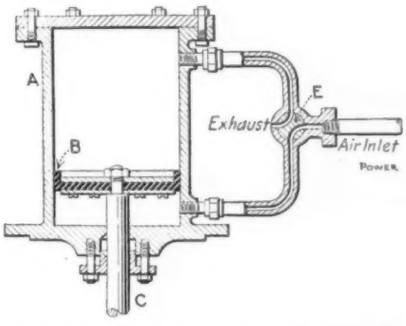
In this connection, a strong solution of potash is very useful in removing grease and dirt from polished-steel nuts, etc., and will make the work of polishing much easier.

W. HOWARD MILLER.

Fort Wayne, Ind.

Pneumatic Lift on Valves

Most modern power plants are provided with air compressors and many of the larger valves might be operated by means of air.



CONNECTION OF VALVE TO CYLINDER

The sketch shows my idea of this means of application of air. The appliance consists of a cylinder *A*, bolted to the upper flange on the valve body; a piston *B*, fitted to the upper end of the valve stem *C*, which is packed, as shown and a four-way cock *E* connected by means of unions to the cylinder *A*. The illustration shows the position of the piston when taking air underneath and exhausting above the piston *B*.

EWDARD SOBOLEWSKI.

Cincinnati, O.

Eyebolt for Manhead

Here is a plan I have been intending to try for overcoming the danger of burns when letting down a manhead, also for making the task of lifting easier: Drill and tap a ⅜-inch hole in the head and screw in an eyebolt.

J. C. LEE.

Jamestown, O.

Mirror Smoke Detector

I ran across a simple arrangement the other day which consisted of a small mirror propped up at such an angle, and at the proper distance from the engine room, that it enables the engineer to see the top of the smokestack from the door or window of his engine room.

This device enabled him to see, without leaving the room, whether the stack was smoking.

W. M. BARTLETT.

Muskegon, Mich.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Inertia of Air Compressor Intake

I was much interested in Snowden B. Redfield's instructive article under the above caption in a recent issue. I do not think that there can be the slightest doubt but that the increase in pressure at the end of the intake stroke is due to the inertia of the moving air column.

It is reasonable to suppose that, with suitable valve timings, the air in the intake connections will crowd into the cylinder as the piston speed slows down toward the out center. Anyhow, most gas-engine designers have taken this action for granted both on the inlet and exhaust strokes. The effects are distinctly noticed on most light-spring diagrams, providing that the valve timings are such as to allow the conditions to be favorable.

On the inlet stroke an increase of pressure is discernible before the out center is reached. Air and gas are substances which are easily compressed, and, since they have weight, they must also possess inertia if once set in motion. The piston sets the column of gas or air in motion, doing work upon it until the piston has attained its maximum speed. The piston is then decelerated through the medium of the connecting rod and crank, giving up its inertia in the process, but the compressible gas, having no such rigid retarding agents, presses on by virtue of its inertia and redelivers the work which has been expended upon it by the piston in compressing itself. This is the only logical conclusion which can be drawn, since if a body has work performed upon it so as to produce motion, that work must be expended somehow before the body comes to rest.

Then, on the exhaust line of a light-spring diagram a drop in pressure is often noticed close to the in center. The column of gases passing down the exhaust pipe causes an inductive action to be set up in that pipe, so much so that many builders of gas engines have their exhaust and air valves open together through quite a few degrees of rotation so that scavenging can be effected by the pure air rushing through the combustion space toward the open exhaust pipe.

Now air could not be induced with the piston still rising or just at the in center unless it were either at a pressure above atmospheric, which is never the case so far as I am aware, or unless work were done on it by a difference in pressure in favor of the atmosphere. To effect the latter proviso the only practicable agent is the column of gases moving away down the exhaust pipe, and since the piston has suffered negative acceleration from its maximum velocity, it can only be the inertia of the column from which the work can be obtained.

I believe that this action was the subject of a patented scavenging device consisting of a long straight exhaust pipe

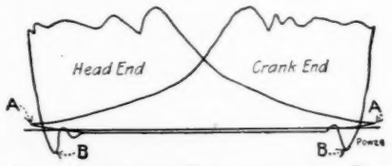


FIG. 1. INDICATOR DIAGRAM FROM COMPRESSOR, SHOWING EFFECT OF AIR INERTIA

of a diameter and length which vary with the size of the engine. At the same time it must be remembered that correct proportioning has much to do with the effectiveness of such a device. An exactly opposite effect to that desired may be obtained by a pipe too small in cross-section or of too great a length for the piston displacement of the engine to which it is applied. The internal resistance then set up greatly detracts from the power available by piling up the pressure in the cylinder at the end of the exhaust stroke instead of decreasing it, thus limiting the amount of fresh mixture which can be admitted to do effective work.

Whether Mr. Redfield's figures and calculations are, or are not, reliable in dealing with a matter of this description, is open to discussion. I think myself that they would vary in each individual case and that to obtain the best results one must have recourse to experimenting with valve settings in conjunction with a reliable indicator.

That the loops *B* in Fig. 1 of his article are not caused by the inertia of the moving parts of the indicator motion is proved by the fact that they are equally marked on diagrams obtained from optical indicators.

JOHN S. LEESE.

Manchester, Eng.

Transmitting Capacities of Pulleys

As the results described in a paper by Professor Sawdon on "The Transmitting Capacity of Pulleys," read before the National Association of Cotton Manufacturers and abstracted in the October 17 issue of POWER, do not fully accord with those obtained in similar tests made at the Worcester Polytechnic Institute, at the Lowell Textile School and with other pulleys in use under factory conditions, careful consideration and discussion seem desirable.

The paper presented was prepared at the request of the Rockwood Manufacturing Company and, it is stated, was originally undertaken with a view to obtaining certain observations on cast-iron pulleys operating at different belt speeds and tensions. Later the test was extended in scope to embrace plain wood and paper pulleys, and still later to include cast-iron, wood and paper pulleys equipped with cork inserts.

Table 1, in Professor Sawdon's paper, referring to the relative capacities of several types of pulleys, is based on results obtained from actual tests, the other table being based on a computation of questionable merit.

Although it is stated that the two tests referred to were made with the corks projecting $\frac{1}{32}$ and $\frac{1}{64}$ inch respectively, Table 1, showing the relative coefficient of friction of the several types of pulleys, does not indicate this but shows corks with five different degrees of projection ranging from $\frac{15}{1000}$ to $\frac{87}{1000}$ inch, no tests of the several types of pulleys apparently being made under like conditions.

Although it is stated that six different initial belt tensions were used, running from 37.5 to 225 pounds per square inch of cross-section, it is interesting to note that the curves have been plotted on a basis of about 170 pounds to the square inch instead of at lower belt tensions, and this in the face of the statement made elsewhere in the paper that it is an accepted fact that the higher the working stress in the belt, the shorter its life. That this tension of 170 pounds is unnecessary is shown by results obtained in daily use and in tests recently com-

pleted at the Lowell Textile School, which were made at a belt tension of 75 pounds to the square inch of cross-section.

Again, it is to be noted that, although the paper pulley is primarily a generator, motor, or other pulley operating at high speed, small arc of contact and usually under adverse conditions, this test is made with a 5-inch single belt on pulleys 24 inches in diameter by 8 inches face running at but 348 revolutions per minute and with a full 180 degrees arc of contact—a quite different set of conditions from those under which motors usually run in mills and factories.

In studying Table 1, which is presented in order that a simple and direct comparison may be made, the above dimensions should be borne in mind together with the fact that no maximum figures are given and that no results are shown at over 2 per cent. slip, although it is elsewhere stated that many kinds of service demand at times overload capacities as much as 50 per cent. of the normal load and that both wood and cast-iron pulleys equipped with cork inserts show a large overload capacity at high slips.

Why, in the absence of actual data, the report should be further amplified by a computation the results of which are shown in Table 2, not based on actual tests, but worked up on an old standard formula on the basis of the altogether undesirable belt tension of 250 pounds to the square inch, I cannot comprehend.

Referring again to Table 1 we find some remarkable results; for example, contrary to any data previously seen by us, we find that the plain paper pulley has 152.8 per cent. greater transmitting capacity than a plain cast-iron pulley, and that a paper cork-insert pulley while transmitting less power than the all-paper pulley still shows 118 per cent. greater transmitting capacity than a plain cast-iron pulley, which figure far exceeds our claims.

LAWRENCE WHITCOMB,
Treasurer,
The Cork Insert Company.

Boston, Mass.

Air Compressor Running Under

In the October 31 number, John S. Leese shows four illustrations representing air compressors and asks to be corrected if wrong. I would say that he is correct in Figs. 1, 3 and 4; in Fig. 2 he is wrong. The steam end of Fig. 2 is correct, but the air compressor is running over, and as it gets its power from the crank shaft, the pressure on the guides would be upward.

This subject is more complicated than it might appear to be at first glance. Take, for instance, a cross-compound machine with the cranks set at right angles. Each steam piston during the first part of its stroke does some work on the crank shaft and some work on the opposing air piston. At half stroke, or a little later, the effective pressure on the air piston will be equal to that on the steam piston; it continues to increase until near the end of the stroke while the pressure in the steam cylinder is falling and it takes work from the other side of the machine, transmitted through the crank shaft and connecting rod to carry the pistons to the end of the stroke. In this case, with the machine running over, the pressure on the guides will be downward during the first part of the stroke and upward during the latter.

JAMES H. CAMPBELL.

Bloomington, Ill.

Referring to Fig. 2 of Mr. Leese's letter in the October 31 issue, it will be seen that the connecting rod of the air compressor and that of the steam engine both connect to the same crank pin.

Mr. Leese states that all the machines in the various sketches are supposed to be running under, but with a machine of a design as shown in Fig. 2, when the steam engine is running under, the air compressor would be running over. Consequently, the thrust would come on the top guide of the air compressor instead of on the bottom guide, as shown.

LOUIS ALLEN.

Union, N. Y.

Sand for Hot Boxes

I know of one engineer, for whom I have the highest respect as to his mechanical ability, and he uses a certain grade of sand for hot bearings.

In connection with his plant he has a machine shop in which is a large grindstone. Whenever this stone required truing up, the engineer would save about a quart of the powdered stone resulting from this operation, and he considered it better than almost anything else he could use for smoothing up a rough bearing.

When he had a new shaft or an obstinate box he would use a small quantity of this stone with a liberal amount of oil. By turning the shaft slowly the surfaces of the bearing were cleaned without any scratches. The application of a stream of water from a hose would soon clean out the sludge.

G. S. SPRAGUE.

Geneva, Neb.

Regarding the controversy on the use of sand to overcome hot boxes, I should like to add my mite of experience.

Once some kind friend put some sand in the outboard of the engine of which I had charge. A few minutes after the trick was played I discovered that the box was smoking hot and all of the babbitt had run out of the lower half.

After such an experience, I would prefer not to use sand as a hot-box cure.

P. C. FORGARD.

Lake Preston, S. D.

I have been very much interested in the discussion regarding the use of sand for hot boxes. I have had considerable experience with hot boxes and I have found that in nine cases out of ten the trouble is caused by grit getting in the bearing. Grit always reminds one of sand, and if I intended to destroy a box as well as damage the shaft, I would not look for anything to do a more complete job than grit (sand). Of course, I am open to conviction, but I would rather let someone else use the sand.

H. F. BUCKLEN.

Kingwood, W. Va.

Dry Back Marine Boiler

Referring to Mr. Fenwick's letter in the October 31 issue, I have charge of a Scotch marine internally fired 135-horsepower boiler. I use 5 pounds of soda ash per week in this boiler, and it has been run for three months in the summer without shutting down.

The length of time the boiler can be run continuously depends on the amount of coal burned or, rather, the amount of ashes which settles in the combustion chamber.

I am burning about 2½ tons of coal per day in winter, one-half soft coal and one-half buckwheat. This requires cleaning the combustion chamber about every six weeks. In the summer, burning 1½ tons per day, it will go three months without cleaning.

I see no reason why this type of boiler could not be run three months at a time, even if a compound were used, as the sediment will settle to the bottom where the fire does not come in contact with the shell upon which it settles. Then it can be blown off once or twice a day to keep the boiler reasonably clean.

In my experience with the internally fired boiler I have had no trouble due to poor circulation.

As to the size in which boilers with corrugated furnaces can be built, to my knowledge boilers of 300 horsepower are common.

LEON N. WEBSTER.

Springfield, Mass.

In answer to Charles Fenwick's questions in the October 31 number regarding internally fired boilers, I will tell of our experience.

Ten years ago we were worrying along with bad water and two return-tubular boilers. We washed one boiler every two weeks, but in spite of our best efforts, the sheets over the fires were frequently burned. We abandoned the return-tubular boilers and installed in their place one 200-horsepower internally fired boiler, having corrugated furnaces, and built for a pressure of 160 pounds.

This boiler has been in continuous service for seven years, and has never been washed oftener than once a month, and it has run as long as four months without washing.

We find no trouble from poor circulation, or in carrying 25 to 30 per cent. overload.

We have been so well pleased with this boiler that we are at the present time operating another boiler just like it of the same horsepower. For bad water, rough usage and long runs without cleaning, this type of boiler has no equal.

W. S. HARKNESS.

Jellico, Tenn.

Running Corliss Engine with One Steam Valve

Answering Mr. Read's inquiry, page 523, of October 3 issue, regarding the behavior of a Corliss engine with the head-end steam valve removed or fastened open, and the head-end exhaust valve disconnected and fastened closed, I say that the engine should operate satisfactorily up to about half load.

There would be no great waste of steam as there was in Mr. Read's experiment with the exhaust valve in operation, and the steam consumption at half normal load would be but little more than if all the valves were operating normally.

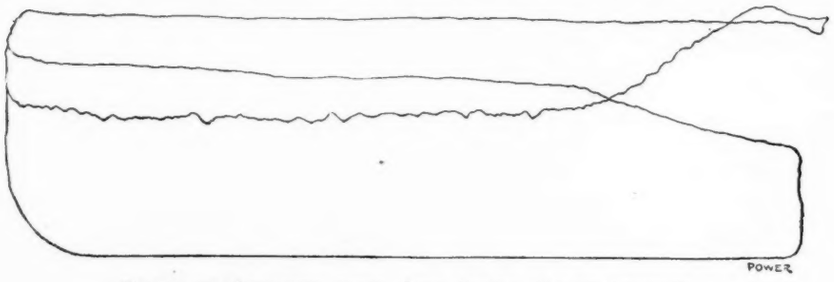
As there would be but one working stroke per revolution instead of two, a variation in speed showing a rise and fall each revolution might be noticeable if the flywheel were very light.

From the diagrams in Mr. Read's letter I should judge that the engine was carrying over three-fourths normal load. With the exhaust valve closed it is doubtful whether the engine would carry this load without trouble. At half normal load the diagram for the crank end would be almost identical with an ordinary full-load diagram. For the head end the admission line would extend the full length of the stroke. With the admission of steam to the crank end the pressure might drop slightly, but it would quickly return and as the piston speed increased would rise a little above the admission line, due to the back pressure of the steam being pumped through the port opening into the steam chest. After the cutoff on the crank end occurs, the steam remaining in the head end would have to be forced back into the steam pipe, thus raising the pressure a little more.

These changes in pressure might be so slight that they would not show up on the diagram, depending on the size of the ports and size and length of the steam pipe, but a small negative loop could be expected.

C. A. CALL.

Schenectady, N. Y.



DIAGRAMS OBTAINED WITH ONE STEAM VALVE REMOVED

Vibrations of Indicator Pencil

I read with care the article by J. W. Taylor, relative to the jagged expansion lines of certain indicator diagrams, published in the issue of October 31.

As Mr. Taylor has written, there is no information at hand relative to these diagrams but to my mind sufficient is shown on the face of them to refute the statement that "they are excellent and the engine is without doubt economical."

I think that my letter in another part of the October 31 issue plainly points out the cause of the wavy lines.

I do not believe that this action can be accounted for by ascribing it to steam action, as I hold the opinion that there is no recoil in steam when it is expanding to a gradually augmented volume, as in springs when they are suddenly released from confinement, and after some years' experience in handling it, I have concluded that its action in an engine cylinder is perfectly smooth.

In connection with this subject and bearing on the reliability of the indicator as an engineer's instrument, the following may be of interest:

Some years ago, I had occasion to indicate an engine which showed this peculiarity and was much surprised to note the result. All kinds of expedients were suggested and tried and as a last resort I decided to solder a triangular-shaped piece of sheet metal to the upper edge of the pencil arm in such a manner that its depth was increased to 1½ inches, making it practically rigid, but the wavy lines could not be disposed of.

This experiment proved conclusively that my indicator was not at fault, but at that time it did not solve the mystery.

It is my opinion that the indicator, when carefully used and its stories read without any attempt to justify the faults of the engines to which it is applied, is the only true guide to correct steam-engineering practice and in my dealings with it, extending over 20 years, I have yet to catch it in a falsehood or doing mysterious things.

CHARLES F. PRESCOTT.

Philadelphia, Penn.

Pressure in Discharge Pipe

In the October 24 issue, Mr. Murphy presents a pump problem. According to the data given the displacement of the pump is about:

$10^2 \times 0.7854 \times 14 \times 2 \times 100 \times 2 =$ 439,824 *cubic inches per minute*

This divided by 231 gives 1904 gallons per minute. Allowing 25 per cent. for slippage, 1428 gallons per minute would be delivered to the discharge pipe.

Assuming that a pressure of 3 pounds is required to lift the check valve and overcome the friction in the 6-inch pipe, the total head in feet in the 6-inch pipe is

$80 + 3 = 83 \div 0.434 = 191 +$ *feet*

On page 523 of the April 4 issue there appears a chart in connection with an article on "The Flow of Water in Clear Iron Pipes," by A. E. Guy. In applying this chart to the problem in hand it is found that with a 3-inch pipe at 190 feet head, which is the head required to force water into the upper tank, only 240 gallons per minute will be delivered. The balance, 1188 gallons, would be pumped into the upper tank. This, however, would be much less, due to the increased friction in the 6-inch pipe.

J. C. HAWKINS.

Hyattsville, Md.

Prevent Standpipe Freezing

Referring to the query of Thomas Nicholson in POWER of September 12, regarding standpipes freezing, I would say that I have a 16-inch standpipe connecting a 150,000-gallon iron tank with a water main. From the surface to the bottom of the tank it is 90 feet, and the tank is in a very exposed place.

The 16-inch pipe is covered with tarred felt, which is wired to hold it in position. A number of 2x4-inch split wooden rings are fitted around the covered pipe, and are placed any convenient distance apart. To these rings are nailed rough but closely jointed boards, of sufficient widths to complete the circle, leaving a 4-inch space between the covered pipe and the boards. This is covered with tarred felt, wooden rings and close-fitting boards. It should be so covered that there will be three sets of rings, putting over each set of boards a covering of tarred felt; the last or outer covering may be of 2- or 2½-inch beaded boards. At the top, where the standpipe joins the tank, a close-fitting molding or strip should be neatly fastened. This cover-

ing, it is said, will withstand the coldest weather.

FRANK C. B. SPEACE.

Cape May City, N. J.

Water Wrecked Low Pressure Cylinder

I have read H. R. Low's letter in the October 31 number about water wrecking the low-pressure cylinder of a cross-compound engine. I had an experience with water in the low-pressure cylinder of a cross-compound engine of the Buckeye automatic, piston-valve type. The engine is 20 and 36 by 33 inches in size and runs at 140 revolutions per minute. When it was about time to stop and there was hardly any load on the engine, water would get into the cylinder and things would start.

I tried several ways of preventing this, even to shutting off the water from the condenser before closing the throttle, but I still would get an occasional dose of water which always opened the relief valves. Finally, I examined the drip pipe on the receiver. This pipe was about 30 feet long and was open to the atmosphere. It had a globe valve and a check valve in it. I removed the pipe and found the receiver very nearly full of water. On examination it proved to be plugged with packing which had come from the high-pressure piston rod. The rod being badly pitted, it pulled the packing into the cylinder a little at a time and finally enough was blown into the drip to entirely close the pipe.

Since placing a new pipe on the receiver I have had no trouble due to water.

JOHN JONES.

Beacon Falls, Conn.

Value of CO_2 Recorder

R. S. Wilhelm states in the October 24 issue that "As the percentage of CO_2 is to a great extent influenced by the draft, it demands that a draft recorder be installed with the CO_2 recorder. A combination apparatus if properly cared for will show on the chart the percentage of perfect combustion, and will show the draft employed at the time the CO_2 was recorded; a study of the chart will show just in what position to set the damper to obtain a draft through the bed of fuel that will give the great percentage of CO_2."

The draft through the fuel bed depends on the amount of air passing and the resistance of the fire. Were this resistance constant, then the amount of air and the percentage of CO_2 would always be dependent on draft, and draft only. But the depth of fuel and depth of ash, accumulation of clinkers, etc., cause wide variation in the resistance to flow of air and no iron-bound rule can be set down as to draft or the damper position to give the highest percentage of CO_2.

PAUL C. BANCEL.

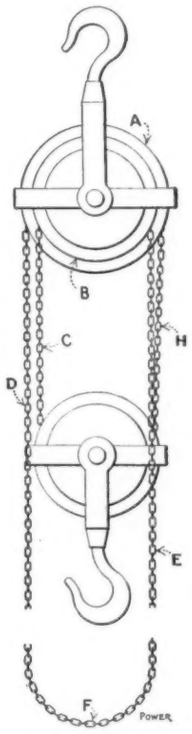
New York City.

"Differential" Chain Block

As regards Mr. Phillips' "differential" chain-block problem in the October 31 POWER, perhaps it can be more easily explained by reference to the accompanying figure.

When 30 feet of chain are pulled at the side *D*, but 28 feet pass up at the side *E*, the other 2 feet being disposed in the loose end of the chain, making the end at *F* $\left(\frac{2}{2}\right)$ 1 foot nearer the floor.

A simple rule for determining the velocity ratio would be: Take the difference between the number of link pockets, in wheels *A* and *B*, and divide by 2. The result will be the lower term



THE "DIFFERENTIAL" CHAIN BLOCK

of the ratio. The higher term will be the number of pockets in the wheel off which you are pulling.

For example, wheel *A* has 15 pockets and wheel *B* has 14 pockets;

$$\frac{15 - 14}{2} = 0.5$$

giving a velocity ratio when pulling at *D* or *H* of 15 to 0.5 or 30 to 1; and when pulling at *E* or *C* of 14 to 0.5, or 28 to 1.

PORTER STAFFORD.

Erie, Penn.

Graft

Referring to the editorial under this caption in the issue of October 31, it seems to me that condemnation for this damnable practice ought not to be directed at the engineer who in a moment of weakness accepts the bribe which is pressed into his perhaps unwilling hands. The party who offers the bribe is the one who should be condemned and in some way made to see the error of his way. I think it is generally conceived that engineers and master mechanics are not paid on a par with men in other trades where the back is used more than the head.

When I first came to New York City, now nearly 12 years ago, I was told that unless I practised "graft" I could not do business in this section. The fact that I am "still at the old stand" is ample refutation of such a statement. As a matter of fact, I can truthfully say that during the 15 years I have been in business for myself, I have been importuned for graft but a very few times.

There are honest engineers and mechanics. Lots of them. It seems too bad that the whole profession should be, as it were, under a cloud because of a few unworthy members who stoop to such practices. So long as the world remains, graft will exist. It does seem, however, as though every honest man should, whenever an opportunity affords, strike at it and do his part toward its extermination.

CHARLES F. CHASE.

New York City.

Personal Efficiency

I have noticed several discussions, in recent numbers of POWER, on efficiency, economy, equipment, etc. When efficiency or economy in the power plant is mentioned we are prone to think at once of the plant itself, of damper regulators, draft gages, CO_2 recorders, patent furnaces, recording gages, wattmeters, coal weighers and other automatic devices. The mechanical papers are always advertising some new apparatus or combination which will produce greater efficiency.

The compound man says that more fuel is wasted because of scale in the boilers than for any other reason; the combustion engineer, that poorly designed furnaces and improper firing are the most prevalent evils; the engine builder, that the most important part of the plant is an economical engine.

One may have the most uptodate plant which money, experience and careful planning can buy and yet fail to secure efficiency.

In the last analysis it must be admitted that the man who operates the plant is the most important factor, as, generally speaking, on him rests the responsibility for efficient operation. Therefore, the first and most important thing is to secure a capable, efficient engineer who "means business."

R. L. RAYBURN.

Kansas City, Mo.

Inquiries of General Interest

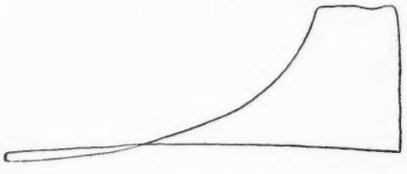
Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Negative Loop in Indicator Diagram

What causes the loop in the high-pressure diagram after the exhaust valve opens to the receiver?

E. W. S.

The steam is cut off so early in the stroke that expansion is carried below the line of pressure against which the engine is exhausting and at the moment when the exhaust valve opens there is a rush of steam, previously exhausted, into the cylinder, raising the pressure in the



NEGATIVE LOOP IN DIAGRAM

cylinder to that in the receiver. The remedy in the case of a compound engine is to lengthen the cutoff on the low-pressure cylinder until the receiver pressure is equal to or lower than the terminal in the high-pressure cylinder.

Full Compression Stops the Engine

Why does a gasolene engine, which runs all right with the compression-relief cock open, refuse to run with the cock closed?

J. M. J.

Any one of several causes could produce this result, namely: Very lean or very rich mixture; premature ignition; retarded ignition; deranged valve mechanism; too high compression.

Oscillation of Chimneys

Do not brick and cement chimneys oscillate in high winds? How much out of center would the top of a well constructed chimney, 125 feet high, lean in a 60-miles-an-hour wind?

H. S. T.

All chimneys oscillate in a wind. It is practically impossible to state what the oscillation would be in the case presented.

The factors which influence the oscillation of a brick chimney are its diameter, the taper of its sides, the material and workmanship and the rate at which the wind is blowing.

Assuming a chimney of 125 feet in hight and 60 inches in diameter, with a 2 per cent. taper and built with fairly good care and material, the oscillation in a 60-miles-an-hour wind should be about 2 inches either side of the true center line.

Effect of Power Factor on the Driving Engine

Does an engine driving an alternator have to develop any more power when the alternating-current power factor is low than when it is high, the true power being the same in both cases?

C. F. R.

A very little more, on account of the increased electrical losses in the circuits when the power factor is low. With a lower power factor, more current is required for the same real power; the extra current increases the losses in all circuit conductors and thereby increases the total power required at the alternator shaft.

Temperature Difference Between Steam and Water

What is the difference between the temperature of the steam in a boiler and that of the water from which the steam is made?

D. M. S.

There is no difference. The temperature at which water will boil or change into steam depends upon the pressure to which it is subjected. Under an absolute pressure of 9/100 of a pound, that is, a vacuum of 29.84 inches, it would boil at 32 degrees. Under a vacuum of about 26 inches it would boil at 125 degrees. At atmospheric pressure or a pressure corresponding to 29.92 inches of mercury it boils at 212 degrees. At 50 pounds absolute, 35 pounds gage, 281 degrees; 100 pounds absolute, 328 degrees; 150 pounds absolute, 358 degrees, etc.

The exact values may be found in the steam tables in any engineer's reference book. There are two books devoted entirely to tables of the physical properties of steam, one by Professors Marks and Davis and the other by Professor Peabody.

Formula for Centrifugal Force

In the formula for centrifugal force,

$$F = \frac{1.2275\,WR}{t^2}$$

how are the figures 1.2275 found? In the formula

$$F = 2R\ 3.1416\ W$$

time is omitted and it is not clearly understood how 3.1416 is changed when time is included.

P. J. B.

$$\text{Centrifugal force} = F = \frac{Wv^2}{gR}$$

where

W = Weight in pounds;
v = Linear velocity in feet per second;
g = 32.16;
R = Radius in feet.

But

$$v = 2\,\pi\,R\,N$$

where

N = Revolutions per second.

Hence,

$$F = \frac{W \times (2\,\pi RN)^2}{32.16\,R}$$

$$F = \frac{W \times 4 \times 9.9\,R^2N^2}{32.16 \times R}$$

$$= 1.2275\,WRN^2$$

Where t = time in seconds for one revolution, $\frac{1}{t}$ would be the revolutions in one second or equal to N.

Substituting in the above equation

$$F = \frac{1.2275\,WR}{t^2}$$

Collapsing Pressure of Corrugated Flue

How is the collapsing pressure of a corrugated furnace flue found?

C. P. C.

The pressure per square inch at which a corrugated flue will collapse is found by multiplying the thickness of the flue in thirty-seconds of an inch by itself and by 1200 and dividing this product by the greater external diameter in inches multiplied by the square root of the length of the flue in inches. The formula is

$$\frac{t^2 \times 1200}{D \times \sqrt{L}}$$

in which

t = Thickness in thirty-seconds of an inch;
D = Mean diameter in inches;
L = Length in inches.

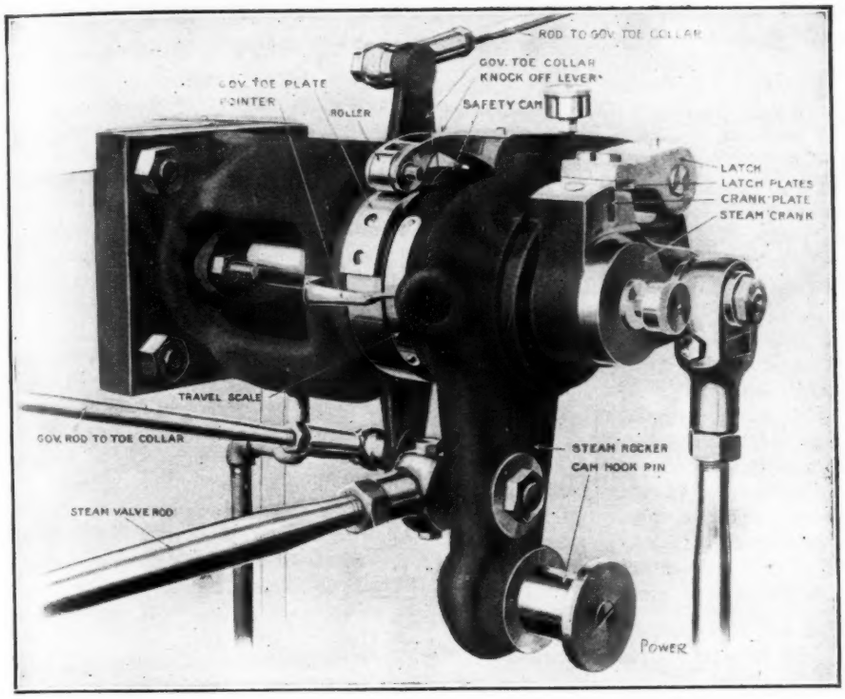
New Hamilton Corliss Gravity Valve Gear

A detail view of the new Hamilton Corliss valve gear is shown herewith. The main features are confined to the latch-block arrangement and the knock-off lever. The outer end of the valve stem has a steam crank to which is fitted a steel crank plate. The top of the steam-rod arm is fitted with a latch rod, on the outer end of which is secured a latch arm. On the inner end is secured the knockoff lever, which carries a roller at its outer end, as shown. This roller rides on the toe collar which is actuated by the governor. A governor toe plate is mounted on this collar, and operates the knockoff lever. There is also a safety cam to prevent the knockoff lever from dropping enough to permit the latch plates to engage and open the valve in case of governor trouble or excessive speed. There is also a travel scale which indicates the amount of valve opening.

The illustration shows the valve gear in a position to open the valve. The steam rocker will be moved toward the right, which will move the latch arm toward the left, and when the latch blocks engage, the valve is opened until the roller on the end of the knockoff lever is lifted by the governor toe plate, which action lifts the latch plate. As soon as the crank plate is disengaged the valve is closed by the dashpot.

When the steam rocker moves toward the left, the latch-plate lever drops by gravity to its original engaging position.

This valve gear is designed to operate noiselessly and positively at speeds of from 150 to 175 revolutions per minute. The latch and cam levers are made of steel forgings. It is manufactured by the Hooven, Owens, Rentschler Company, Hamilton, O.



DETAILS OF NEW HAMILTON CORLISS GRAVITY VALVE GEAR

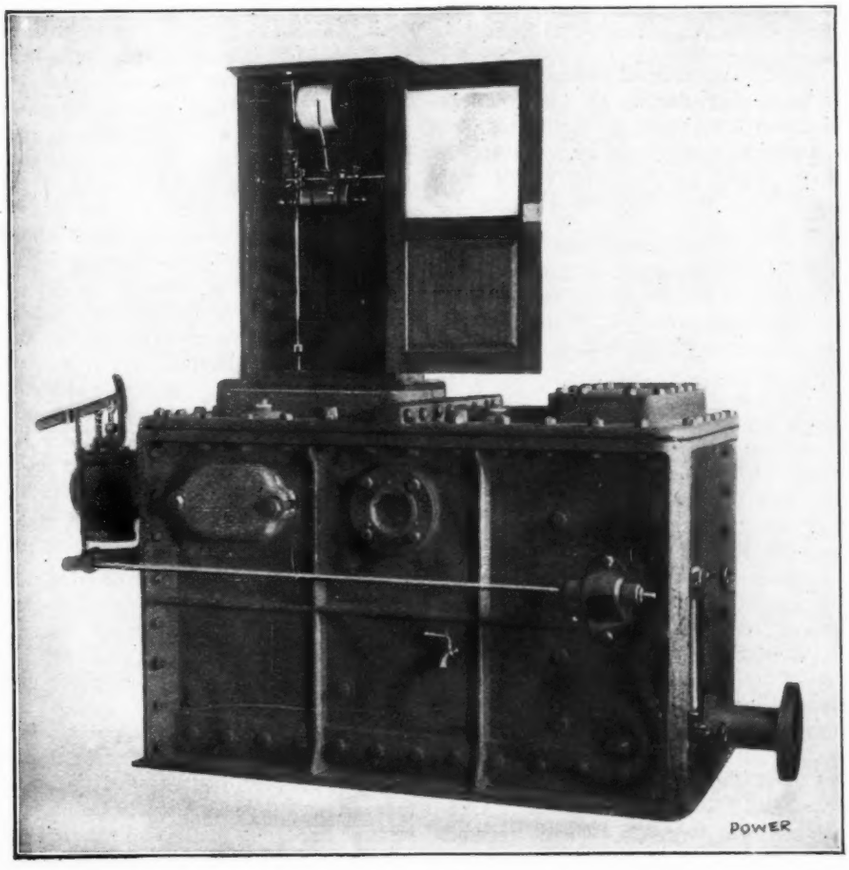
Lea Pressure Recorder

The Yarnall-Waring Company, 1109 Locust street, Philadelphia, Penn., has recently added to its line of Lea recorders a pressure type, suitable for measuring hot or cold water under a vacuum or pressure, as the case may be. The general appearance of this new type is shown in the accompanying illustration, which is an exterior view of the meter with the recording instrument mounted in a separate case on the top cover.

The notch tank is made of cast iron, and is entirely inclosed and designed to withstand any pressure up to 10 pounds per square inch, or a vacuum. This enables the recorder to be placed between the open feed-water heater and the feed pump.

A balanced float valve is shown on the inlet on the left-hand end of the tank. This valve is operated by a float and lever mechanism placed below the weir on the discharge side, so that the weir or the recorder will not be flooded. A water gage is also provided on the right-hand end of the tank for checking the operation of the float mechanism.

On the sides of the tank two glass peepholes are provided for adjusting the recorder to zero while the notch tank is under pressure. This new type of pressure recorder is made in sizes to care for 200 to 10,000 boiler horsepower. Other forms of the Lea recorder have been given previous attention in POWER.



LEA PRESSURE RECORDER

Transportation to Seattle Convention

On November 22 a meeting of the transportation committee of the National Electric Light Association was held at its headquarters in New York City.

Chairman C. H. Hodskinson announced that the Transcontinental Passenger Association had authorized reduced round-trip fares to the Seattle meeting as follows: From Chicago, $65; St. Louis, $62.50; Missouri Gateways (Omaha to Kansas City, inclusive), $55; St. Paul, $55. Dates of sale for tickets under reduced fares are May 27 and 28 and June 3 to 6, inclusive; final-return limit, July 27, 1912.

PERSONAL

R. Sanford Riley, of Providence, R. I., who as president of the American Ship Windlass Company developed the Taylor stoker, has sold out his interest in that company and organized the Sanford Riley Stoker Company to exploit a new self-cleaning underfeed stoker.

SOCIETY NOTES

The tenth annual entertainment and reception of the 10 combined associations of the National Association of Stationary Engineers will be held on December 30, at 8:15 p.m., at Terrace Garden, Fifty-eighth street. Any information on tickets, boxes and the regular calendar may be had by addressing S. I. Schoff, chairman of the finance committee, 225 St. Ann's avenue, New York City.

The annual meeting of the American Society of Heating and Ventilating Engineers will occur at the Engineering Societies building, 29 West Thirty-ninth street, New York City, on January 23, 24 and 25, 1912.

On November 8 and 9 the executive committee of the National District Heating Association met in Detroit, Mich., and unanimously decided to hold the fourth annual convention in that city, fixing the dates, June 25, 26 and 27, 1912. Papers upon the following subjects will be presented at this convention: "Depreciation in Underground Distribution System," "Operation of Turbines and Reciprocating Engines in Connection with Steam Heating Work," "Description of a Combined Steam Heating, Ice Making and Electric Power System," "Radiation Tests," "Heat Losses in Steam Distributing Systems," "Description of a large Hot-water Heating System," "Quality of Steam Supply as Affected by Use of Superheat at Station," "Decentralized Heating Plants," "Relative Economies of One- and Two-pipe Heating Systems in Buildings," "Sources of Trouble in Customers' Installations," "Thermodynamic Economy of Combined Power and Heating Systems," "Different Systems of Underground Construction." One paper is to be presented by the Cleveland Electric Illuminating Company, but the subject has not yet been announced.

NEW PUBLICATIONS

THE COPPER HANDBOOK; A MANUAL OF THE COPPER INDUSTRY OF THE WORLD; tenth annual edition. Compiled and published by Horace J. Stevens, Houghton, Mich. Price, green buckram, $5; full library morocco, $7.50.

This well known work is a standard authority on the subject of copper and copper mines for the world. It has 1902 octavo pages and describes 8130 mines and mining companies, with descriptions of from two or three lines in the case of deceased companies up to 21 pages, as in that of the Anaconda mine, which yields one-eighth of all the world's output of copper.

The 24 miscellaneous chapters embrace the history, chemistry, mineralogy, metallurgy, brands and grades, alloys and substitutes for copper, with a copious glossary and a chapter of statistics containing over 40 tables, thoroughly covering production, consumption, movements, prices, dividends, etc.

PROBLEMS IN THERMODYNAMICS AND HEAT ENGINEERING. By Edward F. Miller, Charles W. Berry and Joseph C. Riley. John Wiley & Sons, New York and London. Paper; 67 pages, 6x9 inches. Price, 75 cents net.

A pamphlet compiled primarily to supplement the courses of instruction in heat engineering at the Massachusetts Institute of Technology. It is in no sense a textbook; in fact, it contains no dissertation at all upon the subject, only the questions and answers being given. These questions cover a wide range, treating of the laws of thermodynamics, thermodynamics of gases, saturated and superheated vapors, flow of fluids, air and internal-combustion engines, steam boilers and engines, compressed air and refrigeration and heating.

While the book is admirably adapted for the particular use for which it was written, still it would have found a wider field for use had the problems been worked out in detail, thus demonstrating the methods employed in solving them rather than the mere answers.

In a 94-page book bearing the title "Heating and Ventilating," the Green Fuel Economizer Company, of Matteawan, N. Y., has brought together the information required for the designing and proportioning of hot-blast outfits for heating, ventilating, drying, etc. The book contains some two or three dozen tables of temperatures required in rooms for various purposes; heat transmission through building materials; heat given off by occupants and by lights; standard sizes of hot-blast heaters; frictional resistance of air washers; relative humidities; humidities and temperatures throughout the United States; amounts of air required for ventilation; equivalent air pressures, velocities and horsepowers; total weight of air at various barometers and temperatures; pressure and power consumed in friction; speed, capacity and power of steel-plate fans; friction of air through hot-blast coils, etc. The text takes up not only the usual details relating to the construction of fans, heaters and heating and ventilating systems, but also the calculation and designing of piping systems, giving for the latter two methods differing somewhat, namely, that used in the office of the supervising architects at Washington, and that proposed by Riltschel and covering the resistance of sheet-iron pipes and of angles, bends, branches, grills or registers, etc. There is also a chapter on the loss of head of air flowing through orifices and equivalent orifices, in which is presented a method of combining the resistances of ducts in parallel and series connections analagous to Ohm's and Kirchoff's laws for electrical circuits. Another chapter gives the result of an extensive series of tests upon Green's "Positivflo" steam-heating coils, by means of which heaters of suitable sizes may be selected for any given duty. The general illustrations of the book inculde not only views of buildings equipped with heating and ventilating apparatus built by the Green Fuel Economizer Company, but also detailed plans, elevations and phantom views, showing the actual arrangement of the fans, heaters, piping, outlets, etc. Copies of this book will be sent upon request to architects, heating and ventilating engineers and others concerned with the purchase, design, or operation of heating plants.

BOOKS RECEIVED

PRACTICAL MARINE ENGINEERING. Third edition. *International Marine Engineering*, New York. Cloth; 794 pages, 5¾x9 inches; 350 illustrations; tables; indexed. Price, $5.

SHORT COURSE IN ELECTRICAL TESTING. By J. H. Morecroft and F. W. Hehre. D. Van Nostrand Company, New York. Cloth; 154 pages, 5½x8¼ inches; 46 illustrations. Price, $1.50.

MAXIMUM PRODUCTION IN MACHINE SHOP AND FOUNDRY. By C. E. Knoeppel. The Engineering Magazine, New York. Three hundred and sixty-five pages, 4¾x7½ inches; illustrated; indexed. Price, $2.50.

HANDBOOK ON THE GAS ENGINE. By Herman Haeder and W. M. Huskisson. McGraw-Hill Book Company, New York, and Crosby, Lockwood & Son, London, England. Leather; 317 pages, 6½x9¼ inches; illustrated; tables; plates; indexed. Price, $5.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

Dr. Osler promulgated a theory that a man over 40 was of no use to the community and had best be gently put away.

If his theory had been put into practice some of the world's best bets would never have been cashed.

James J. Hill was punching tickets in a little station at St. Paul at 45—then he built the Great Northern Railway.

J. P. Morgan would have struck his last trial balance at 46—and the financial world would never have known the power of his genius.

Thomas J. Foster would have walked into the chloroform cabinet at 47—and the International Correspondence schools would have been unknown.

There's a romance about that great business at Scranton that makes fiction seem commonplace.

Foster, a village editor, originated a new system of education and, reaching into the mine, the shop and the store, has literally brought the wor d to school.

In 1886 he was editing and publishing a weekly paper—*The Mining Herald.*

Mining conditions were very dangerous at that time. He found what he believed to be the cause—ignorance on the part of mine workers of the scientific principles of mining. So, as a means of helping those who desired to improve, he started a column of questions and answers on the subject of mining. It was an immediate success.

Then came the idea of the bigger plan—to go back to the beginning, to the elements of arithmetic, mensuration and formulas and teach the whole subject of mining by correspondence.

From that idea has grown the present system of correspondence instruction.

The story from that day to this is one of sweeping growth. Today that business requires the brains and energies of 4200 employees. The schools now give instruction in over 200 courses.

It was accomplished by a man after his forty-eighth year.

It was entirely built on good advertising plus good salesmanship.

Take this little lesson from the last thought:

If correspondence instruction properly conducted is a good thing, it should be known throughout the world.

Advertising spreads a knowledge of it.

And that, after all, is Advertising's mission.

To spread the *news* of good things from one end of the country to the other, whether the "good" thing be food or machinery.

To knit people of widely separated localities together in common knowledge of common things.

To give the mining man in one place the same information possessed by another nearer "headquarters."

Advertising's *object* is to sell goods, but its *mission* comprehends many things not dreamed of in the philosophy of the ordinary reader.

Advertising of machinery is on a high plane—trustworthy and reliable.

First, because it doesn't *pay* to have it any other way—

There are 49 other reasons, but the one will suffice.

A liberal reading of the ads in the Selling Section is a liberal education in itself.

BUSINESS ITEMS

The Bruce-Macbeth Engine Company, Cleveland, Ohio, builder of vertical multi-cylinder gas engines, reports 26 recent sales of its engines, having a total of 3105 horsepower, ranging in size from 35 to 350 horsepower.

The Lytton Manufacturing Corporation, manufacturer of steam, return and vacuum traps, pressure and feed-water regulators, pump governors and boiler blow valves, has appointed Joseph E. Hernandez, 56 Aguacate, Havana, Cuba, agent for the sale of its appliances in the island of Cuba, Isle of Pines and Jamaica.

The eleventh edition of the illustrated catalog of McNab & Harlin Manufacturing Company, 55 John street, New York, has just been issued. It is a cloth-bound volume of nearly 400 pages, illustrating and describing its large line of valves, pipe fittings and pipe for power-plant purposes. A copy will be sent to any interested engineer.

The Kerr Turbine Company, Wellsville, N. Y., advises that over 700 of its machines, aggregating more than 50,000 horsepower, are in active service and that more unfilled orders are now booked than at any previous time in the history of the company. Although its plant has been materially enlarged, a night shift has been necessary for the past two and a half years.

NEW EQUIPMENT

Upton, Que., will equip new waterworks.

Athol, Mass., contemplates installing water meters.

Georgetown, Miss., voted to construct waterworks.

Rockwood, Ont., will equip a new hydro-electric station.

Falmouth, Ky., voted to construct an electric-light plant.

Madisonville, Ky., voted to issue $75,000 bonds for waterworks.

Worthington, Ohio, will build a new municipal waterworks plant.

The Cleveland (Ohio) Dye Works will install a new power plant.

Phœnix, Ore., has voted bonds for a municipal waterworks system.

Leominster, Mass., will purchase a new boiler for its stone crusher.

The Brantford (Ont.) Cold Storage Company will equip a new plant.

The Sunset Power Company will equip a new plant at Kamloops, B. C.

Malden, Mass., has issued $12,000 bonds for improvements to its water system.

Albion, N. Y., is considering the installation of a muncipal water-supply system.

The Chino Copper Company, Santa Rita, N. M., is building a new electric power plant.

The Cleveland (Ohio) Dye Company has let contract for the erection of a boiler house

The town of Carmel, Ohio, is considering the erection of a municipal electric-light plant.

The Edison Illuminating Company, Detroit, Mich., will erect an addition to its downtown plant.

The Hygienic Ice and Cold Storage Company, Birmingham, Ala., will erect a new plant.

Amity, Ore., contemplates the installation of a waterworks plant. City council is in charge.

Fire destroyed the plant of the Campbellsville (Ky.) Electric Light Company. Loss, $30,000.

An $80,000 power house will be built in connection with the Windsor hotel, Montreal, Canada.

Point Claire, Que., will equip a new waterworks pumping plant and a new electric-lighting plant.

The Northwestern Knitting Company, Minneapolis, Minn., will erect a $35,000 addition to its power house.

The Centralia (Wash.) Light and Traction Company is erecting a new electric power station near Centralia.

The Crystal Ice Company, Elizabeth City, N. C., will increase the capacity of its plant from 35 to 75 tons daily.

The Eagle Brewing Company, Utica, N. Y., will erect a new pump house and will install a new 175-horsepower boiler.

Power-plant equipment will be required fo the new $600,000 hotel to be erected by the Erie (Penn.) Hotel Company.

The Mt. Whitney Power Company, Porterville, Cal., will improve its power system. New equipment will be installed.

The El Rano (Okla.) Interurban Railway Company is contemplating the construction of a new substation at Banner.

H. C. Wood Company, of Norwood, Ohio, is having plans prepared for a $50,000 ice plant to be erected at Wyoming, Ohio.

The Greenville (Me.) Light and Power Company is erecting a substation at the Portland-Monson slate quarry, at Monson, Me.

Plans are being prepared by the City Electric Company, San Francisco, Cal., for a new substation on Folsom street, near Sixth street.

Fort Pierce, Fla., will vote on $15,000 bond issue for the construction of an electric-light system and $45,000 bonds for waterworks.

The Federal Power and Water Company, Tucson, Ariz., is planning the erection of a large electric power plant. H. W. Roche is president.

The Dallas (Tex.) Electric Light and Power Company will enlarge its building and increase the capacity of its light and power plant.

The Lake Megantic (Que.) Pulp Company will buy turbine engines for a new power plant to be built on the Chaudiere river, at Lake Megantic.

The Ragland (Ala.) Water Power Company is having plans prepared by Martin H. Lide, of Birmingham, Ala., for the construction of a water-power plant.

The Rector (Ark.) Light and Water Company has been granted a franchise for water and light plant. Will install new generators, etc.: also new water plant.

The Big Blue Mining Company, Wickenburg, Ariz., is planning the erection of a power plant on the Hassayampa river. Robert H. Browne is in charge.

A new central heating and lighting plant will be built at the Tuskegee Institute, Tuskegee, Ala., to cost about $250,000. W. G. Franz, Cincinnati, Ohio, architect.

The Cincinnati (Ohio) waterworks will make extensive improvements, including a new 17,000,000-gallon pump for the Torrence Road station, and a 7,000,000-gallon pump for the Western Hills station.

The Nevada Valley Power Company, Reno, Nev., has been incorporated with $2,500,000 capital by A. D. Ayers, H. D. Danforth, A. A. Smith, of Reno, and others. Site for power plant has been secured on the Truckee river, near Vista, Nev.

NEW CATALOGS

General Electric Company, Schenectady, N. Y. Bulletin No. 4883. Curtis steam-turbine generators. Illustrated, 48 pages, 8x10½ inches.

The Goulds Manufacturing Company, Seneca Falls, N. Y. Bulletin No. 101. Triplex plunger pumps. Illustrated, 12 pages, 8x10 inches.

Allis-Chalmers Company, Milwaukee, Wis. Bulletin No. 1075. Belted alternating-current generators. Illustrated, 16 pages, 8x10½ inches.

Dean Brothers Steam Pump Works, Indianapolis, Ind. Pony Catalog No. 86. Pumps and condensers. Illustrated, 64 pages, 3½x6 inches.

Dearborn Drug and Chemical Works, Chicago, Ill. Pamphlet. The Treatment of Boiler Feed Waters. Illustrated, 16 pages, 3½x8 inches.

Albany Lubricating Company, 708 Washington street, New York. Pamphlet. "Death to Friction." Albany grease. Illustrated, 16 pages, 5x7 inches.

American Air Compressor Works, 26 Cortlandt street, New York. Catalog No. 19. Fairhurst air compressors, vacuum pumps, air receivers, air-lift well pumps. Illustrated, 30 pages, 6x9 inches.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

WANTED—One expert aid (location of subsurface structures) at $7.04 per diem. A competitive examination will be held January 29, 1912, for filling the above position. For further information address "Commandant," Navy Yard, Brooklyn, N. Y.

BOILER MEN—Several energetic men who are familiar with the operation of steam boilers can secure good positions as salesmen on straight salary and in good territory; in making application, state age and experience. Address "Boiler," care POWER.

AGENTS WANTED—To sell lubricating oils, belts, hose, paint and varnish, for power machinery, to factories, mills, auto owners, stores, threshers; exclusive territory to right party; oil experience unnecessary. Manufacturers Oil & Grease Co., Cleveland, Ohio.

WANTED—Two assistant shop superintendents at $5.04 per diem, each; a competitive examination will be held at the navy yard, Philadelphia, Penn., January 8, 1912, for filling the above positions. For further information address "Commandant," Navy Yard, Philadelphia, Penn.

WANTED—One mechanical engineer at $2500 per annum; a competitive examination will be held December 18, 1911, at the United States Naval Academy, Annapolis, Md., for filling the above position. For further information address "Superintendent," United States Naval Academy, Annapolis, Md.

WANTED—As assistant in engineer's office, young mechanical engineer, who is a first-class draftsman, and preferably one who has had some experience in construction; healthy locality in South; salary, one hundred twenty-five dollars per month; excellent opportunity for advancement to the right man. Answer "Phosphate," care POWER.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

GRADUATE ENGINEER—Selling, operating, broad German, English, American experience; expert in fuel economy, seeks position (change) with reliable firm; will accept $30 a week to commence and commission. Box 536, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS—C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

PATENTS—Herbert Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make a free search and report if patent can be had and the exact cost.

A STRONG, old established manufacturing company, with a national selling organization, wants to add a new line of building material or construction specialty to manufacture and sell. Address Box 534, POWER.

ENGINEERS AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

ENGINEERS OR MANAGERS of steam plants, for a short time the best indicator outfit on the market free with your first order for boiler compound, in powder or brick form; no pay until satisfactory. N. A. Olson Chemical Co., Manitowoc, Wis.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ONE ECO MAGNETO watchman's clock complete; six stations; in good condition. Address "Manufacturer," P. O. Box 186, Newark, N. J.

FOR SALE—One single cylinder, 66 horsepower gas engine and producer; made by the Power and Mining Machinery Co. Avery Scale Co., North Milwaukee, Wis.

FOR SALE—8x10 Skinner engine, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

IDEAL, simple engine, 14x14, 125 horsepower at 100 pounds pressure; rebuilt with new Chuse shaft, new piston and valve; in first-class condition; larger engine installed, reason for selling. F. A. Heermans, city clerk, Mattoon, Ill.

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